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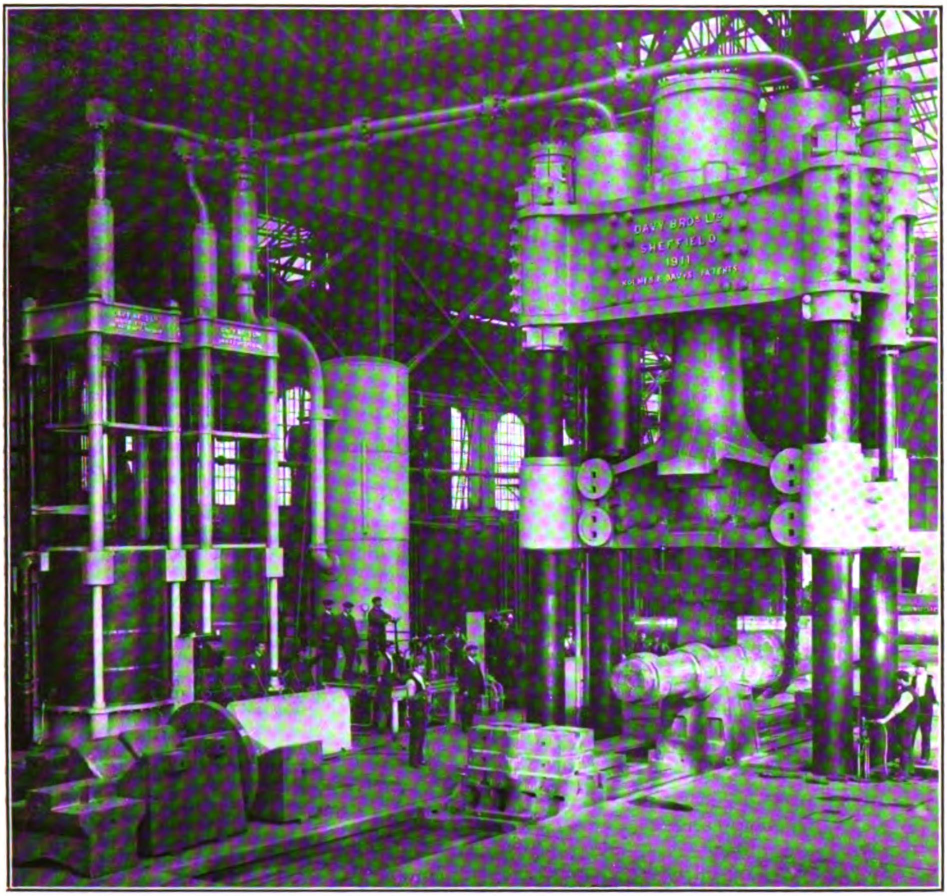


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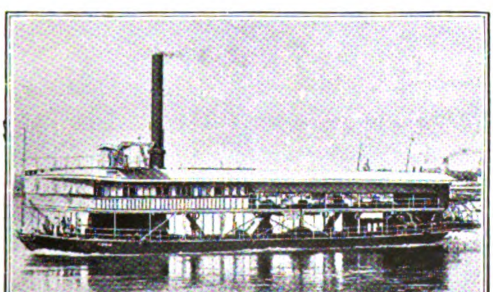

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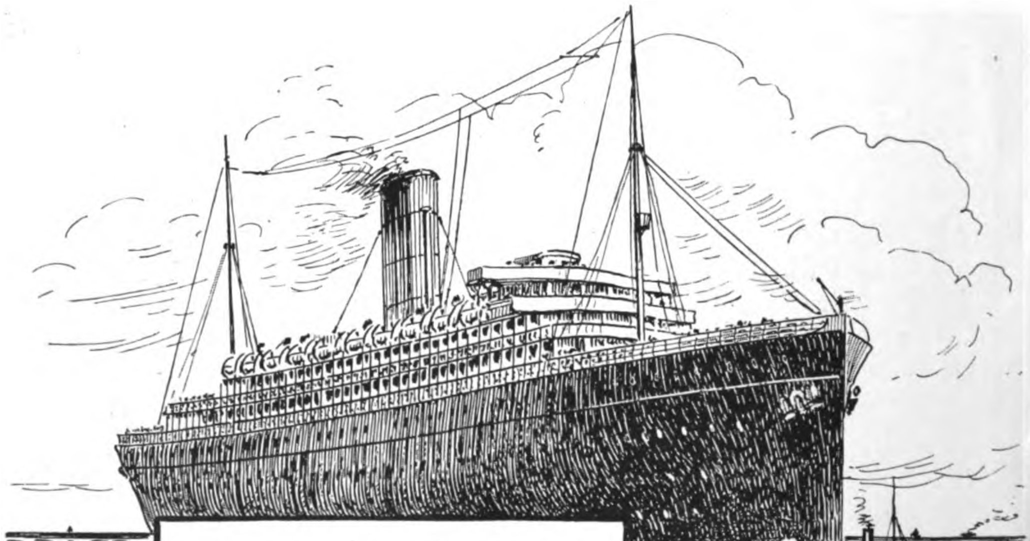

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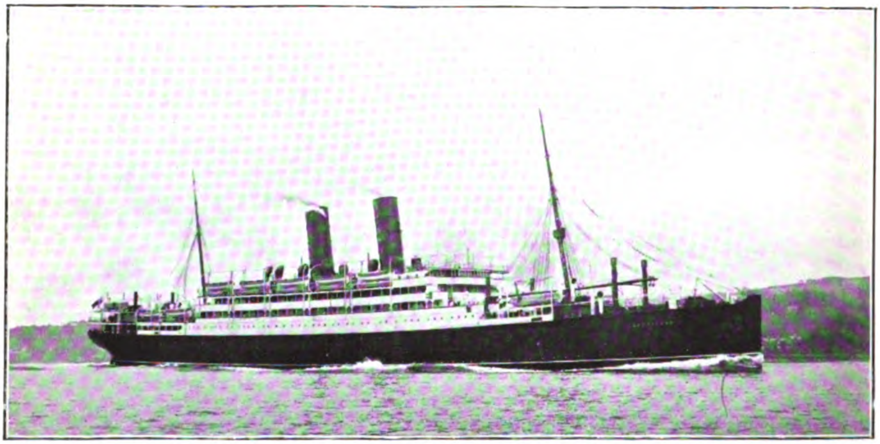

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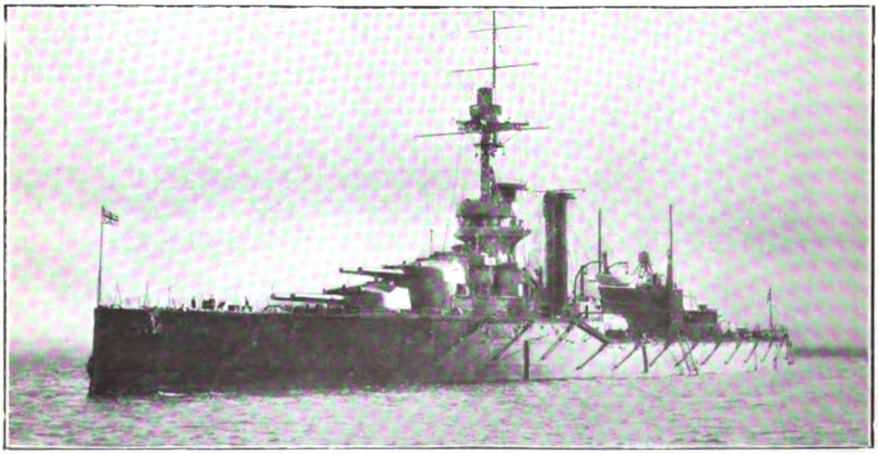

**A British Battleship.**


Williamh 'Dowell 1921

# BRASSEY'S

# NAVAL AND SHIPPING ANNUAL.

# 1921-2.

EDITED BY

ALEXANDER RICHARDSON,

*Associate Member of Council, Inst. Nav. Arch.;*
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THIRTY-THIRD YEAR OF PUBLICATION.

LONDON:

WILLIAM CLOWES AND SONS, LIMITED

94, JERMYN STREET, S.W. 1.

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# PREFACE.

THE reception of the last issue of "Brassey's Naval and Shipping Annual," in its new and extended form, more than fulfilled anticipation. It has taken its place as the only publication of its wide scope, dealing with naval and shipping affairs, in the English-speaking world. The welcome accorded to it in the British Dominions, as well as in the United States, France, Japan, and other foreign countries, has been specially gratifying. This opportunity is taken to thank the naval authorities of this and other countries for their assistance in maintaining what may be described as "the Brassey tradition," and leaders in the shipbuilding, engineering, and shipping world have placed us under a debt of obligation by the cordial spirit in which they have contributed to the establishment, on sure foundations, of a handbook and reference volume, which it is hoped may prove not unworthy of the high prestige which those industries hold throughout the world.

In the present issue we have been able more fully to carry out the original conception of what "Brassey's Naval and Shipping Annual" should become. Advantage has been taken of many helpful suggestions, with the result that a larger number of articles are contained in the present volume; the appendices have been extended, and the illustrations, tables, and diagrams are more numerous than in the issue of 1920–21.

As in former years, Commander C. N. Robinson and Mr. John Leyland are responsible for the chapters dealing with the progress and development of the British and foreign navies, respectively, as well as for the lists of ships and flotillas which appear in the Naval Appendix. In view of the Washington Conference, it is believed that the very full details which are given of the present and prospective strengths of the leading fleets of the world will prove of peculiar value to those who are concerned with the problem of the limitation of naval armaments. It is noteworthy that there is not a single man-of-war of any description on the slips in this country, a condition for which no parallel can be found in the records of the past hundred years and more. On the other hand, the United States

and Japan are pressing forward their shipbuilding programmes. In this connection the particulars which are published of the rise and progress of British, American, and Japanese naval expenditure may be studied in association with the usual comparative tables. It will be seen that the building of the four new battle cruisers for the British Fleet, which the Government, with the full approval of Parliament, has decided to lay down, will synchronise with the completion of thirteen post-Jutland ships in the United States, and of five in Japan.

All the official information, British and German, bearing upon the Battle of Jutland, has now been made available to naval students, and the time is at hand when considered judgment will be formed on the tactics adopted by the two fleets. Lieutenant-Commander Ichiro Sato, of the Imperial Japanese Navy, makes an interesting contribution to what may be described as the Jutland literature. The article was written while this officer was attached to The Higher Naval College of the Japanese Navy, and, as will be seen, he has brought a well-stored mind to the consideration of the tactics of the British and German Fleets. Commander Ichiro Sato is now acting as one of the Japanese delegates to the League of Nations.

Prominence is given to three associated articles by Admiral Sir Reginald Bacon, Rear-Admiral S. S. Hall, and Major-General Sir W. S. Brancker. These three officers, from their several standpoints, discuss the future of naval warfare; Admiral Bacon forecasts the sphere of the capital ship, with its heavy guns; Admiral Hall examines the potentialities of the torpedo, with special reference to the submarine; and Sir Sefton Brancker emphasises the influence which, in his opinion, air power will exercise on sea power. The chapter by Major-General Sir George Aston, of the Royal Marine Artillery, on the problem of Empire Defence, forms an appropriate footnote to this discussion.

Engineer Vice-Admiral Sir George Goodwin, Engineer-in-Chief of the Fleet, is again a welcome contributor; he deals, with the fulness of knowledge that has come to him during his long and distinguished career, with the progress of auxiliary machinery. In view of the radical new departure which has been taken by the Navy Department of the United States, Mr. F. D. H. Bremner traces the progress which has already been made with the electric drive for ships of war as well as for merchantmen; this form of propulsion has been definitely adopted in the new capital ships of the American Fleet, and it is also being tried experimentally in ships of commerce. Commander H. Rundle writes an informative article on naval staff work, in which he describes the functions performed by a naval staff under peace conditions. Mr. L. Cope Cornford contributes an

incisive study of the limits of criticism of war. Since the great struggle, in which most of the nations of the world eventually became involved, drew to its close, a great deal has been written upon the manner in which the fleets and armies were used, and Mr. Cope Cornford suggests that the public should be on its guard against ill-informed criticism of great naval and military leaders. Mr. Edward Fraser makes additions to the list of books dealing with the war, which appeared in the last issue of "Brassey's Naval and Shipping Annual," reminding us of the stream of volumes which is still issuing from publishing houses in this country, the United States, France, and Germany. Commander Robinson discusses the latest developments in armour and ordnance.

The Merchant Shipping Section opens with a new feature, for which Sir Westcott Abell, Chief Ship Surveyor of Lloyd's Register of Shipping, has become responsible. He describes, with characteristic accuracy and technical knowledge, the progress of the world's mercantile marines, devoting attention to the tendencies of shipping policy in this country and abroad. A complementary chapter, contributed by Mr. James Richardson, is concerned with propelling machinery, and, in continuation of his article in the last issue, he traces the latest developments of the internal-combustion engine; 405,941 tons of shipping are now under construction which will be fitted with internal-combustion engines, indicating the progress which is being made in the adoption of this new type of propulsive agent.

Sir W. J. Noble, ex-President of the Chamber of Shipping of the United Kingdom and President of the Baltic and White Sea Conference and also of the North-East Coast Institution of Engineers and Shipbuilders, traces the sensational fall of freights which has taken place during the past few years. While he refuses to take a pessimistic view of the future, he quotes facts and figures which refute the suggestion that the cost of sea transport is responsible for the present high cost of living. That the steamship or motor-ship may in future find a rival in the commercial airship is the thought prompted by the article by Commander Sir Trevor Dawson on the commercial airship, of the possibilities of which he has made a close study.

Sir Norman Hill, the outstanding exponent of the economics of shipping, as well as the Secretary of the Liverpool Steam Ship Owners' Association, writes upon coastal shipping. He reminds us of the important functions which the small ship performs in the movement of British imports and exports—their collection and distribution. Mr. Percy Hillhouse, D.Sc., the newly elected Professor of Naval Architecture in Glasgow University, deals with the cost of speed at sea, and at a moment when there is a demand for a

quickening of sea communications between the Mother Country and the Dominions, his technical study of the problem is particularly timely. Mr. J. Foster King, who recently paid an extended visit to Japan, conveys, in an interesting contribution, his impressions of the progress which shipbuilding is making in that country. Japan is destined to become one of the leading carriers of ocean-borne commerce.

From time to time it has been suggested that the use of liquid fuel for naval and mercantile purposes will be limited by the supplies available. Sir Frederick Black examines the world's resources of petroleum fuel oil, and his conclusions are calculated to exercise considerable influence on future policy. In the light of the effort which was made some time ago to bring about the nationalisation of the British Mercantile Marine, Mr. Sanford Cole describes the experiences of the United States, France, Canada, and Australia, which have all, in varying degree, experimented with the State ownership of shipping. The two final chapters are concerned with the future of German shipping and Lord Inchcape's sale of the standard ships which the British Government found on its hands when the armistice was signed and of the ex-enemy tonnage surrendered by Germany to us under the Peace Treaty. Lord Inchcape may congratulate himself, as this article indicates, on having carried out with conspicuous success the greatest operation of the kind which has ever been attempted, to the great advantage of the country generally.

We have again to express our thanks to many naval officers and others for suggestions and assistance. Mr. Andrew Scott, the Secretary of Lloyd's Register of Shipping, has put us under a great obligation for the readiness with which he placed statistical data once more at our disposal.

ALEX. RICHARDSON.
ARCHIBALD HURD.

# NAVAL SECTION.

## CHAPTER I.

### THE BRITISH NAVY.

### POST-WAR DEVELOPMENT.

THE outstanding features within the naval ambit since the last issue of the "Annual" was published are the changes on the civil side of the Admiralty Board, and the decision to resume the building of capital ships. In neither case was any variation of policy involved. Mr. Walter Long, who had filled the position of First Lord with singular devotion to duty in the arduous and trying time following immediately upon the end of hostilities, was obliged to relinquish office in January on account of ill-health, a peerage being conferred on him in recognition of his long and distinguished services to the nation. The cause of his departure was sincerely regretted by the Navy. The appointment of Lord Lee of Fareham as his successor was officially announced on February 14, 1921, and the new First Lord, who from 1903 to 1906 held the office of Civil Lord of the Admiralty, soon gave evidence, by the issue of his Memorandum accompanying the Navy Estimates,* that he was in accord with the policy of the Board under his predecessor. It fell to Lord Lee, within three weeks of taking office, to sign and pass the Navy Estimates on March 4. When these were presented to the House of Commons on the 14th, it was found that a sum of 2½ millions had been taken for the "replacement of obsolescent ships." The Estimates were expounded in the House by Colonel Sir James Craig on the 17th, when it was indicated that four was the number of new capital ships to be provided. This was the last important act of Colonel Craig as Secretary to the Admiralty prior to his resigning office to become Premier of the Northern Parliament of Ireland. Simultaneously with this vacancy, it was felt that, as the First Lord was a Peer, the Civil Lord should be in the House of Commons, and accordingly the Earl of Onslow, who had succeeded the Earl of Lytton in this post on November 1, 1920, was transferred to another office. On April 2, the appointments of Colonel L. C. M. S. Amery, late Under-Secretary for the Colonies, to be Parliamentary Secretary to the Admiralty, and of Commander B. M. Eyres-Monsell, R.N., retired (Emergency List), formerly Treasurer of the Household, to be Civil Lord, were officially announced. A complete change of the Parliamentary element on the Board was thus made, a transformation very rare except upon a change of Government.

The need for providing new capital ships was accepted by the country with comparatively little controversy. It would not have

* The full text of the Memorandum is published in the Naval Appendix.

been altogether surprising if it had been questioned and opposed, for history shows that after any great war in which the land forces have played a conspicuous part, popular interest in the Navy has usually suffered a decline. In particular was this the case after the Russian war. But the manner in which the nation responded to the expressed conviction of the Service that new big ships were necessary, was a welcome sign that the supreme importance of the work of the Fleet during the war had been recognised and appreciated. When first the intimation was made to the Cabinet, at the beginning of December, 1920, that, in the opinion of the naval advisers of the Ministry, the construction of capital ships must be resumed, there were aspects of the matter which called for investigation before the recommendations of the Sea Lords could be accepted. It was not so much from a technical standpoint that such action was necessary, of course, as this would have been tantamount to a want of confidence in the Board. The feeling of the Cabinet was that the question should not be settled, on account of its economic and political bearings, until a full and complete investigation had been made. This feeling was shared by the country and concurred in by the Navy. On December 9, Mr. Austen Chamberlain, then Chancellor of the Exchequer, announced in the House that, while determined to maintain the Navy at a standard of strength which should adequately secure the safety of the Empire, the Cabinet, before sanctioning a programme of new construction, were bound to satisfy themselves that the lessons of the war had been definitely ascertained. They therefore decided that the Committee of Imperial Defence should institute at once an exhaustive investigation into the whole question of naval strength as affected by the latest developments of naval warfare, and no programme was to be presented to Parliament until the results of this inquiry had been considered. The Sub-Committee appointed for the purpose included Mr. Bonar Law (Chairman), Mr. Churchill, Mr. Long, Sir Robert Horne, Sir Eric Geddes, and Admiral of the Fleet Earl Beatty. It examined many witnesses from the Fleet and elsewhere during December and January, and the effect of its report, which was not published, was to confirm the necessity for building more capital ships. Comment was made upon the composition of this Sub-Committee, and comparisons drawn between it and the Committee on Design, presided over by Lord Fisher, which had recommended the building of the Dreadnought some sixteen years before. As Mr. Lloyd George pointed out, however, the Committee of 1904 was not one appointed by the Government, but was a purely technical Committee appointed by the Admiralty to review the details of the fighting ships, the types of which had already been decided upon by the Admiralty. On this occasion, he said, "it was not merely a question of capital ships *versus* small ships, but of the best method of securing the defence of the country in the light of the lessons of the war."

### Great Ships or ——?

It is well to place on record certain utterances of the Sea Lords and other prominent naval officers at this time, indicating their

views as to the need for this country not to allow its Fleet to decline to such a point that it could no longer fulfil its traditional *rôle*. In receiving the Freedom of Sheffield on July 23, 1920, Admiral of the Fleet Earl Beatty said :—

Since the war ended there has been no new construction, but progress in science, in technique, in ingenuity, go together to shorten the life of a man-of-war. In the spheres of science and of experimental work the Navy is better equipped to-day than it has ever been before. With our efforts extending in that direction, we can afford to delay construction by assimilating and co-ordinating all the lessons of the war, so that when the time does come such money as should be expended may be expended in the wisest and in the right direction.

Following this clear hint that the cessation of shipbuilding could only be temporary, Mr. Walter Long, the First Lord, in replying to the toast of His Majesty's Ministers at the Sheffield Cutlers' Feast on October 14, made the following statement :—

In the old days, in pre-war days, we made our preparations as to what the strength of our Navy should be by estimating the strength of one, two, or three of the navies that might be opposed to us in the world. . . . To-day it may be—I hope it is—true that we have no enemy to challenge our supremacy. But that is not the only standpoint from which we have got to examine the position of the King's Navy. We cannot afford as trustees of the peace of the world to allow our supremacy to be challenged. If we ask our countrymen to make sacrifices I am sure they will accept them, even at times like this. I say quite openly as trustees of the British Navy that if we rest on our oars, if we do less than we need do, we shall find, quite apart from any competition, that our Navy is no longer the efficient force it ought to be, because we shall have allowed our ships to become obsolete and fallen behind in the race, not for competition of strength, but for efficiency, on which that strength depends.

It was on the same occasion that Rear-Admiral Sir Roger Keyes, who replied for the Navy, said that the officers of the Fleet at sea had absolute confidence in the Admiralty, and felt assured that, when the time came to step forward, the country would be asked to provide the material necessary to maintain our supremacy. "We sailors," he continued, "have a goodly heritage, and we are not disposed to surrender our birthright to any one—not even to a kinsman who is a good and tried friend." A few days later, on October 28, Admiral of the Fleet Earl Beatty delivered his address as Lord Rector of Edinburgh University, taking for his subject "Sea Power," and after a survey of the principal wars in which the destiny of empires had been decided through the command of the sea, he reminded his hearers that there was no greater fallacy than to speak of "navalism" as the sea counterpart of "militarism," or to refer to the British Navy as a baneful influence. Earl Beatty added :—

It is by trade and by science that we best serve the common interest. For the profitable pursuit of trade, peace and security are essential. By sea power is security gained. Without peace there is no security. Without security there is no trade. Without trade there is no sea power. Sea power is then essentially a power for peace; unaggressive itself, it is a shield against aggression. . . . In conclusion, I ask you to bear in mind that history shows no instance of sea supremacy once yielded being regained.

As to the manner in which the doctrine enunciated could be applied in the present circumstances, an outline was given on December 16, 1920, by Rear-Admiral Frederick L. Field in a speech in London. The Third Sea Lord and Controller said :—

The main thing was to provide new vessels to take the place of worn-out and obsolete ships, so that we might hold our own. If we read history we should see that after all our wars we had neglected our Navy, and had had to pay double for doing so. It was plain to every sailor and citizen that there was no excuse for risking that. We could not build warships without having special plant, and very special skilled labour. The plant and labour cost millions of money, and took many years to find, and if we allowed it to be scrapped it would cost ten times as much to build up again, and perhaps so long a time that if a crisis came we should not be prepared. The unemployed at the present moment had nearly reached a million, while the demand for the construction of merchant ships was on the wane. Were we going to add to the misery and unemployment, or were we going to provide something to relieve it? It might, he thought, be a good thing to replace the merchant shipbuilding by constructing the ships of war that would be necessary over a very long period. This was better than having to do it in a hurry.

This brings up the question of the design of the future capital ship, upon which there was considerable controversy in the *Times* and other journals during December and January. It is unnecessary to refer to this at any length here, but among those who took part in the discussion were Admirals Sir Percy Scott, A. W. Waymouth, S. S. Hall, Sir Herbert King Hall, Sir Cyprian Bridge, W. H. Henderson, Sir Reginald Bacon, Sir Reginald Custance, Sir Lowther Grant, Mark Kerr, and Sir S. Eardley Wilmot, together with a number of other officers, publicists, naval architects and the like. The correspondence in the *Times* was afterwards published in pamphlet form under the title of "The Future of Navies." Although there was much divergence of view, the bulk of opinion upon this question appeared to agree with the conclusions put forward by Admiral Sir Doveton Sturdee, the Commander-in-Chief at the Nore, in a speech at the annual banquet of the Association of Men of Kent and Kentish Men on December 8, the anniversary of his victory at the Falklands six years earlier. The Admiral pointed out that although the submarines were a great potential danger, there was a way of meeting them. He was a torpedo man, but during three years with the Grand Fleet he never remembered an occasion when the Fleet was afraid to go to sea because of submarines. It always went to sea whenever it wanted to, and took the necessary precautions. "If we were to start over again," said Sir Doveton, "with a submarine fleet, we would eventually find ourselves back at the surface fleet. We could not do away with the surface vessel. We must build it to be torpedo-proof, but we must still have it."

## Fleet Reductions.

While, in the main, the Fleet organisation outlined in the "Annual" of last year remains in force, considerable reductions have been effected owing to the financial stringency, amounting in one case to the entire abolition of a squadron—that in South America. As regards capital ship strength, the reduction from twenty to sixteen in the total in full commission, announced by the First Lord in his Memorandum, was obtained by withdrawing the battleship Royal Sovereign and battle-cruiser Tiger from the Atlantic Fleet; and the battleships Emperor of India and Centurion from the Mediterranean Fleet. The Royal Sovereign was reduced to reserve complement at Portsmouth on January 28, 1921, but the Tiger was

to remain in full commission until shortly before the commissioning of the Renown in the autumn. The Mediterranean ships were, in April, ordered to be reduced to three-fifths' complement and to be kept at Malta as a station reserve.

From May 3, 1921, the two battle squadrons which had formed a part of the Atlantic Fleet since its constitution on April 8, 1919, were merged into one, Vice-Admiral Sir William Nicholson, formerly in command of the Second Squadron, assuming command, with his flag, as before, in the Barham. This meant the abolition of one vice-admiral's and one rear-admiral's command in the Fleet. Rear-Admiral E. B. Kiddle, C.B., hauled down his flag in the Valiant as Rear-Admiral of the Second Battle Squadron on April 8; Rear-Admiral H. M. Doughty, C.B., followed suit in the Resolution as Rear-Admiral of the First Battle Squadron on April 14; and Vice-Admiral Sir Sydney R. Fremantle in the Revenge as Vice-Admiral Commanding the First Battle Squadron on May 3. From this date, Rear-Admiral Sir Rudolf Bentinck, formerly Naval Secretary to the First Lord, was appointed to be the new Rear-Admiral of the First Battle Squadron, with his flag in the Revenge. The battleships Barham, Malaya, Valiant, and Warspite became the First Division of the new Squadron; and the Revenge, Ramillies, Resolution, and Royal Oak the Second Division.

As regards the destroyer flotillas of the Atlantic Fleet, the Fourth Flotilla, commanded by Captain Dashwood F. Moir in the Bruce, was selected for placing in reserve. This reduced the destroyer strength to six flotilla leaders and forty-eight destroyers, and, instead of their being arranged in three flotillas as formerly, they were divided into six as from May 1, 1921. In future, a "destroyer flotilla" is to be regarded officially as consisting of one flotilla leader, commanded by a Captain (D), and two divisions, each consisting of four destroyers. The Mediterranean Flotilla, however, was to retain its former organisation temporarily, and to be regarded as a double flotilla. The light-cruiser strength of the Atlantic Fleet remains as last year, two squadrons of five vessels each. These forces have continued during the year to provide one or two units for duty in the Baltic.

Coming to the squadrons on foreign stations, it will be found that the only one which has not been reduced from the strength originally allotted to it in March, 1919, is that in China. The Fourth Light-Cruiser Squadron in the East Indies now consists of three ships instead of four, the Conquest, which was allocated to it, not having been sent out. The obsolete cruiser Highflyer, refitted in 1919 at a cost of over £95,000 for duty as flagship of this station, was, in March, 1921, ordered to be paid off for disposal at Bombay, and the Comus to become temporary flagship until the arrival from South American waters of the Southampton. At the Cape, the Sixth Light-Cruiser Squadron, the original strength of which was four units, now consists of two, the Lowestoft and Dublin. The Chatham was not sent out, as proposed in 1919, but went to New Zealand instead, and in March, 1921, the Birmingham was ordered home. From the Eighth Light-Cruiser Squadron, in North American waters, the Calliope was withdrawn towards the end of 1920 and paid off at

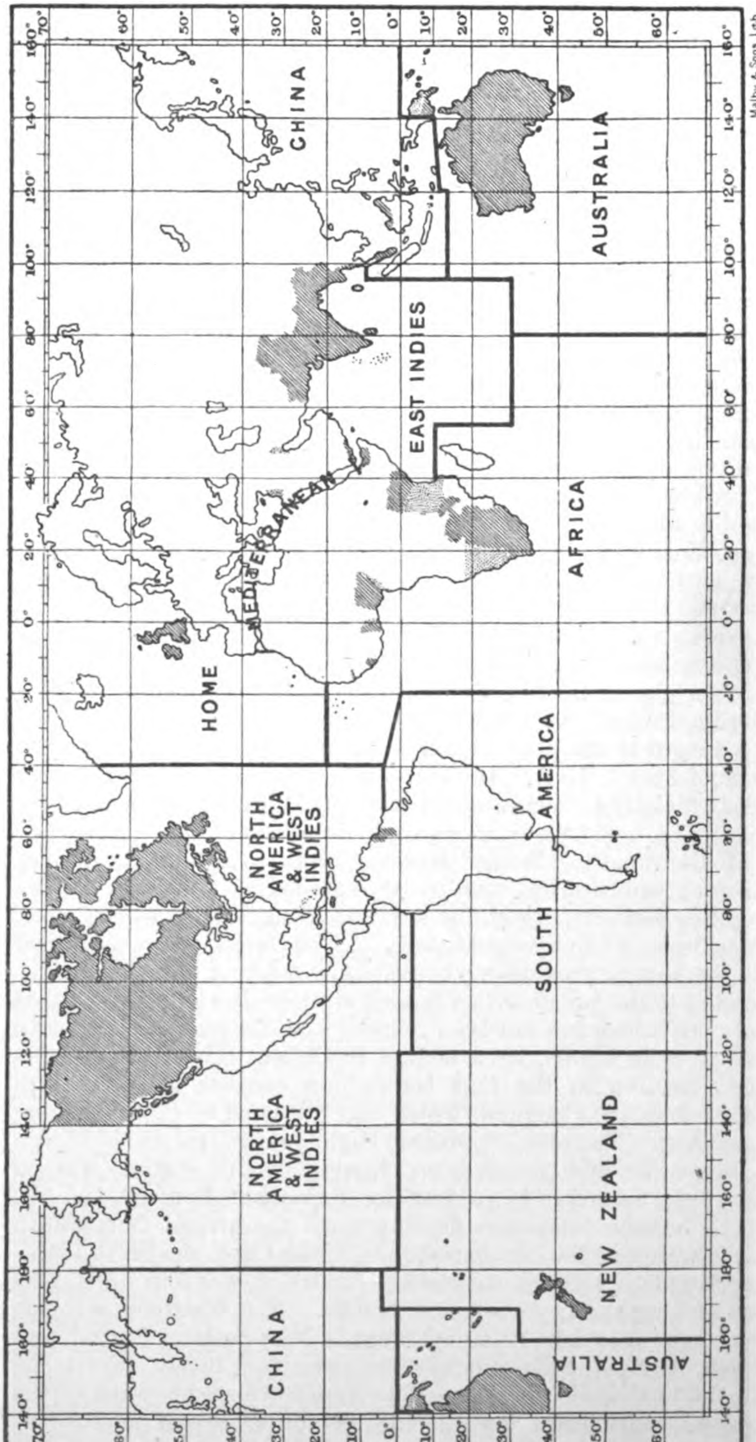



CHART SHOWING LIMITS OF BRITISH NAVAL STATIONS.

*(The British Empire is shown by ruling and the Mandatory Territory of the British Empire by stippling.)*

Chatham on January 12. The appointment of Rear-Admiral in command of this squadron was abolished on April 8, 1921, when Rear-Admiral Sir Allan F. Everett, who had held it for two years, hauled down his flag in the Calcutta. The three cruisers were then brought under the direct command of the Commander-in-Chief on the Station, Vice-Admiral Sir William Pakenham, whose new flagship, the Raleigh, was commissioned at Devonport on April 19, 1921, and left for Bermuda on August 1. From the Seventh Light-Cruiser Squadron, stationed in South America, the Yarmouth had already been withdrawn and reduced to the reserve at the Nore some three or four months before the First Lord announced in his Memorandum that the squadron was to be abolished. The Weymouth, accompanied by the sloop Petersfield, left Rio for home on March 30, and was paid off at Chatham on June 1. The Dartmouth, with several officers from the late flagship Southampton on board, arrived at Devonport on May 24 from Rio de Janeiro, having called at Gibraltar, and with her paying off there were no cruisers of the Weymouth type in commission.

Other changes of a minor character in the sea-going Fleet, all with the object of economising in men, material, and money, may be briefly mentioned. On February 1, the Admiralty decided to pay off the battleship Temeraire, training ship for Dartmouth cadets, and the cruiser Carnarvon, training ship for public school cadets, and to combine their work in one vessel, the battleship Thunderer being chosen. The last cruises of the Temeraire and Carnarvon ended in April, 1921, and the Thunderer left Portland on her first cruise with cadets on June 24. The Admiralty also ordered in February the battleship Commonwealth, at Cromarty, and the monitors Erebus, at the Nore, Terror, at Portsmouth, and Marshal Soult, at Devonport, to be paid off. They had been employed as gunnery training ships and firing tenders, and their work was ordered to be combined in the Orion, formerly flagship of the Vice-Admiral Commanding the Reserve Fleet, which was relieved by the Conqueror. In November, 1920, the number of drifters attached to the Atlantic Fleet was reduced from 38 to 30. This followed the establishment of a reserve of drifters at Portsmouth, Portland, and Rosyth, two at each base, one steel and the other wood, for general duties when required by ships and vessels. Care and maintenance parties, consisting of four ratings for each pair of drifters, were to be provided, but as men for the purpose were not available in the depots the necessary ratings had to be detailed from the Atlantic Fleet.

## Warships' Commissions.

A revised scheme of continuous commissions came into force at the beginning of 1921. The plan had been approved in principle before the war, but its adoption has since been in abeyance. It was in the nature of a reversion to the system in vogue in the ships on what was known as "home sea service" up to 1904, when nucleus crews and two-year commissions came into operation. In the new scheme, one-sixth of the crew is exchanged every four months,

instead of 25 per cent. every six months as before 1904. The whole of the complement is thus relieved after two years. An Admiralty order dated November 24, 1920, stated that the normal length of commission for ships on foreign stations would be two years, exclusive of the time spent on passage or awaiting suitable opportunity for passage. Continuous commissions do not, of course, apply to ships on foreign service.

Closely allied to this question was that of the duration of officers' appointments, which was reviewed by the Board in an order dated March 2, 1921. To avoid long periods of unemployment, it was decided that all appointments of commanders and lieutenant-commanders would be for two years, whether ashore or afloat, at home or abroad. An extension of one year, making three years in all, was to be considered, provided it could be stated that (*a*) it was necessary in the interests of the Service; or (*b*) that personal hardship would be caused by relief at two years. The extension was, however, to be confined to appointments as King's Harbour Masters (not Assistants), officers in charge of detention barracks, and Superintendents or Assistant-Superintendents in the Hydrographic and Compass Departments. The appointments of Naval Attachés were to be, as formerly, "during pleasure." As regards Divisional Officers of Coastguard, their appointments were to be for two years, with an extension of one year in all cases where recommended by the Commander-in-Chief and Admiral Commanding Reserves, and approved by the Admiralty.

## Coastguard Reductions.

Reference was made last year to the changes in the Coastguard Force, by which the control of the stations was brought more directly under the Commanders-in-Chief and Senior Naval Officers at the ports. Referring to this matter at the Lord Mayor's Banquet on November 9, 1920, Admiral Sir Dudley De Chair, the Admiral commanding Coastguard and Reserves, said that the reorganisation had enabled the Admiralty to enrol in the Force many of our seamen who had completed their full term of service afloat. "The Force," he said, "did very good service during the war, and now in peace time keeps its lonely watch and ward round the coasts, manning war signal and wireless telegraph stations, preventing smuggling, looking out for wrecks, saving life, and assisting the great lifeboat services." On March 23, the Admiralty ordered the Coastguard stations at Hessle, Barton-on-Humber, Banklands, Thornham, and Leigh (in the Nore Command); Ryde, Southsea, Millbrook, Eling, Marchwood, and Crowlink (in the Portsmouth Command); and Stonehouse, Shaldon, and Porthallow (in the Plymouth Command), to be closed. Certain changes were also made in the Divisions. Berwick Division was renamed Blyth Division; Sunderland Division, Tynemouth Division; and Whitby Division, Tees Division. The two former changes were made on January 1, and the last named on May 15, 1921.

## New Construction: Capital Ships.

The time is not yet ripe for a consideration of the four new capital ships which are to be built to replace vessels which have become obsolete. On May 25, 1921, the Secretary of the Admiralty announced in the House that the detailed designs were not sufficiently far advanced for tenders to be invited.* It was anticipated, he added, that the construction of the ships would take approximately three years from the date of the contracts being signed. It had previously been stated officially that the dimensions of the slips at the royal dockyards were not adequate for the construction of the capital ships of the new type, but that the question of the time and cost of alterations was being investigated before the time came to place orders for them. An important question also raised by the resumption of capital-ship building is that of docking accommodation. It has been stated that no further liability in this respect will be incurred by the new vessels; any dock which will take the Hood will also take them. In Committee of Supply on May 24, the Civil Lord gave the following list of docks large enough to take the Hood:—At Rosyth, three; at Portsmouth, one, and another could be made available with slight alterations; at Liverpool, the British Commercial dock and the Gladstone dry dock; and at Quebec, the Champlain dry dock. There were also some floating docks suitable, and two large *ex*-German floating docks, could be made suitable.

In accordance with a promise made in March on the introduction of the Navy Estimates, the Parliamentary Secretary of the Admiralty, on the vote for shipbuilding in the House on August 3, gave as much information as was permissible concerning the new capital ships. The statement then made is reproduced in the Naval Appendix. After affirming that our policy is not one of competition or of challenge, but simply one of replacing obsolete ships already relegated to the disposal list, he showed that there were under construction whole fleets of vessels of a type incomparably more powerful than anything afloat at the battle of Jutland. Japan had eight, all to be completed by 1925, and had voted money for eight more by 1928. The United States, not counting four battleships of 32,600 tons, equipped with 16-in. guns, vessels considerably more powerful than our latest types, the "Royal Sovereigns" and "Queen Elizabeths," will have completed by the end of 1924, or beginning of 1925, no less than twelve ships of over 43,000 tons. The four British capital ships will be battle-cruisers of the "Hood" type, but with improvements in the matter of protection and armament which will embody the experience of the war and enable them to hold their own with any vessels of their class in other navies. They will mount 16-in., and not 15-in., guns. As regards under-water protection, Mr. Amery said that the question had been exhaustively examined. The practical experience of the Fleet with the bulge method of protection, and the results of experiments therewith, were, in August, 1918, submitted to a Committee presided over by Lord Jellicoe, and this Committee recommended that all new battleships and battle-cruisers

* Tenders were invited from eight firms in August.

should be fitted with full bulge protection, and that a modified form of it should be given to smaller vessels. The Admiralty are satisfied that they have secured a form of under-water protection which, as far as possible, will meet all contingencies.

Announcing the decision to build the new ships in private yards, Mr. Amery said that the Board had certain immediate considerations to face, which left them no alternative but to put the ships out to tender. The first was that of urgency, since to lengthen the slips at Devonport and Portsmouth would take twenty and twenty-four months, respectively, working night and day, and our replacement programme had already been postponed to the utmost limit. The second consideration was that of economy, since the slip alterations would cost £350,000 at Devonport and £650,000 at Portsmouth, and to spend this million sterling on enlarging Government slips when at least six private slips were ready and waiting for the work was unjustified in the present financial stringency. Finally, the Secretary referred to the question of employment and the Government's special responsibility to the great dockyard centres which depend upon it and which have little or no alternative employment to look to. He affirmed, however, that the Admiralty regard it as essential that they should be able to build any type of ship in the Royal Yards, and that they intend, as soon as the financial situation allows, to bring the latter up to date.

A modification of the policy outlined in March, 1921 (see the First Lord's Memorandum), regarding the dockyards at Pembroke and Haulbowline was announced by Mr. Amery on August 3, when he said in reference to Pembroke:—

While it would not be justifiable to maintain the yard in future at its present, or even its pre-war, strength, in view of the inadequacy of its equipment for the purposes of the modern Navy, we have come to the conclusion that it will be feasible and advantageous, without incurring any fresh capital expenditure on equipment, to make use of its existing facilities to a limited extent, and for certain classes of ships. We are accordingly prepared to keep Pembroke Dockyard in existence at a reduced permanent strength of about 1,200 men. On this basis, the yard could always have two smaller vessels in hand, and, at the same time, find room on the existing site for the oil-fuel depot already approved to be provided in this neighbourhood. . . . As regards Haulbowline, I am afraid further investigation only confirmed the view that the maintenance of this small dockyard could not be justified on grounds either of economy or efficiency. . . . The actual naval base at Queenstown will, of course, still be maintained.

## Light Cruisers.

The outstanding feature of the naval construction since the last issue of the "Annual" has been the cessation of work in the private yards. Gradually all the vessels which these establishments had in hand at the Armistice, and the contracts for which were too far advanced to be cancelled, have been transferred for completion to the public yards. With the arrival at Portsmouth, in February last, of the flotilla-leader Rooke from the works of Messrs. Thornycroft, and the arrival later in the year at Chatham of the destroyer Whitehall from Messrs. Swan, Hunter and Wigham Richardsons', there were no surface warships left in the private yards, and no submarines after the arrival at Portsmouth of L27, from the Vickers'

works at Barrow-in-Furness. This state of things was unique in modern times, probably unique in the history of the Navy, for it would be difficult to find a period when the shipbuilding yards had been absolutely devoid of Government building.

Following the usual practice in the "Annual," it will be convenient to deal with the vessels concerned by classes, and after the completion of the Hood, recorded last year, the next vessels in point of importance are the light cruisers. Of the large light cruisers of the oversea commerce-protecting type, the Raleigh has during the year joined the Hawkins in commission. After many delays due to the scarcity of men, she was commissioned at Devonport, on April 19, 1921, for service as flagship on the North American Station. The Frobisher, at Devonport, is proceeding slowly, but no date is assigned for her completion. The Effingham, at Portsmouth, was launched on June 8, 1921, the naming ceremony being performed by the Marchioness of Salisbury. The Frobisher and Effingham are being engined at the respective dockyards with machinery supplied by the Wallsend Slipway and Engineering Company and Messrs. Harland and Wolff, respectively.

There is nothing to add to the details given last year in respect of the Enterprise and Emerald. They are in hand at Devonport and Chatham Dockyards, respectively, on transfer from the yards of Messrs. John Brown and Co., and Sir W. G. Armstrong, Whitworth and Co., but no dates are yet assigned for their completion.

Coming to the three remaining cruisers of the "D" class, the Durban, Despatch, and Diomede, it was indicated in the Navy Estimates in March, 1921, that they would be passed into commission during the ensuing twelve months, and with them the Capetown, the sole remaining cruiser of the "C" type. The Durban and Capetown are due for completion in November, 1921, the Despatch in January, and the Diomede in March, 1922.

## Destroyers and Submarines.

Of the eight torpedo craft—two flotilla leaders and six destroyers —in hand at the beginning of the current financial year, four of the destroyers were ordered to be completed before March, 1922. These were the Thracian, transferred to Sheerness from Messrs. Hawthorn, Leslie and Co.; the Witch, transferred to Devonport from Messrs. Thornycroft; the Worcester, to Portsmouth from Messrs. White, of Cowes; and the Wren, to Pembroke from Messrs. Yarrow and Co. The other four vessels, consisting of the flotilla leaders Keppel and Rooke and the destroyers Shikari and Whitehall, remain over for completion to the financial year 1922–23. Apart from the Effingham, the only launch of a ship of war during the past year has been that of the Rooke, which was put afloat from the Thornycroft works at Woolston, Southampton, on September 16, 1920, when Lady Thornycroft performed the naming ceremony. On April 13, 1921, the Admiralty ordered this vessel to be renamed Broke, after the famous flotilla leader of that name which served in the Dover Patrol

during the war and had since been sold to Chile, by whom she was originally ordered.

There were also five submarines completing when the Navy Estimates were prepared. Portsmouth had the L26, from Messrs. Vickers; Devonport the L54, from Messrs. W. Denny and Bros., Dumbarton; Chatham the K26, from Messrs. Vickers; and Rosyth the L69, from Messrs. Beardmore. The last-named was allotted for completion in 1921-22, but the others were only to be advanced during that year. The fifth vessel was the L27, at Messrs. Vickers, which, as mentioned, was ordered to be transferred to Portsmouth as soon as ready, but not to be completed during the financial year.

## Aircraft-Carriers.

The aircraft-carrier Eagle (*ex*-Chilean battleship Almirante Cochrane) was engaged in various flying tests in the Channel in the autumn of 1920, during which time the Argus, the aircraft-carrier attached to the Atlantic Fleet, was undergoing a refit and having certain additions made to her flying equipment at Devonport. On the conclusion of the trials, the Eagle was paid off at Devonport on November 16, 1920, and taken to Portsmouth, to be completed by the dockyard. The Navy Estimates show that, up to March 31, 1922, the huge sum of £3,310,042 is expected to be spent upon the Eagle. This is a colossal figure for a non-combatant unit. It is, however, unavoidable if the aerial arm of the Navy is not to be stultified. The Eagle has a displacement at load draught of 22,790 tons. She is 625 ft. long by 92 ft. broad, and with a mean load draught of 24-ft. Turbine engines of 55,000 horse-power give her a speed of 24 knots. Messrs. John Brown and Co. are the manufacturers of her machinery. Referring to the case of the Eagle during the debate on August 3, 1921, Mr. Amery said that she was taken up for conversion in February, 1918, when no other vessel was available. The high total figure at which she stands in the Estimates is due largely to the purchase price paid for her as a partly-built battleship. At the Armistice, work was so far advanced on her that it would not have been economical either to have scrapped her or to have reconverted her for delivery to Chile, and her trial, while still incomplete, showed that she will make a most efficient aircraft-carrier.

The Hermes, the other aircraft-carrier due for completion during the present financial year, is of special interest as being the first aircraft-carrier in the British—and probably in any—Navy to be specially designed and built for such duty. The first vessel to be so employed in our Navy was also named Hermes—the light cruiser of the Highflyer class, which was adapted for the purpose in 1913, and which was lost in the war, being torpedoed by a submarine in the Dover Straits on October 31, 1914. The next aircraft-carrier, the Ark Royal, which served at Gallipoli and in the Mediterranean, was originally a cargo steamer, with her superstructure on the fore-part cleared away to make a level starting platform, and accommodation for the aeroplanes in her hold. Several vessels were, of course, taken up as aircraft-carriers in the war, among them the cross-Channel

turbine steamers Empress, Engadine, Riviera, Manxman, and Vindex; the Atlantic liner Campania, which was the first to be attached to the Grand Fleet; and others.

In 1917, there was a call for large and fast aircraft-carriers, and, as an alternative to building a new ship at much greater cost, the Furious, light battle-cruiser, was adapted and eventually became the flagship of the Admiral Commanding Aircraft in the Grand Fleet. In November, 1919, she was reduced to the reserve at Rosyth, at which yard she is undergoing reconstruction, for which a sum of £326,000 is taken in the current Navy Estimates. £6,000 of this is for propelling machinery and all the rest for hull, fittings, and equipment. The Cavendish, one of the five light cruisers of the "Elizabethan" series, was also transformed into a carrier, and renamed the Vindictive. She, too, is now in reserve, at Portsmouth, but has been used during the present year to transport relief crews to the Mediterranean. The Argus, which has been the principal aircraft ship in the Atlantic Fleet since the armistice, was originally laid down by Messrs. Beardmore and Co. at Dalmuir as a passenger and cargo steamer for the Lloyd Sabaudo Company, of Genoa, but work on her having been stopped since the beginning of war, the Admiralty took her over to convert into an aircraft-carrier. It was in the Argus that the flue gases and smoke were first carried away aft and emitted from the stern. This arrangement not only reduced the tendency to create air pockets above the deck of the ship, but also left the latter absolutely free from the obstruction of funnels.

Designed by Sir Eustace d'Eyncourt, the Hermes was laid down by Messrs. Armstrong, Whitworth and Co., in January, 1918, and launched on September 11, 1919. She was towed from the Tyne on July 1, 1920, to be completed at Devonport Dockyard, where her machinery, supplied by the Parsons' Marine Steam Turbine Co., has been installed. It consists of twin-screw geared turbines of 40,000 horse-power, giving a speed of 25 knots. The oil capacity at load draught is 1,000 tons, and the maximum capacity 2,000 tons. The Hermes has a length of 548 ft., a breadth of 70 ft., and a mean load draught of 18 ft. 9 in. Although she is smaller than the Argus, being of 10,950 tons as compared with the latter's 14,450 tons, she is understood to have a larger flying deck, and, being good for five knots' more speed, should prove a decided acquisition to the Fleet. She is, moreover, better able to defend herself against attack, having ten 5·5-in. and four 4-in. A.A. guns, whereas the Argus has only two 4-in. and four 4-in. A.A. guns. The hull is fashioned with a straight stem and a wide flare at the bows, so as to ensure as dry a deck as possible for the seaplanes carried. Bulges are also fitted as a protection against under-water explosion. Like the Argus, the Hermes has no funnels.

The only auxiliary which calls for notice is the new hospital ship for the Atlantic Fleet. Purchased in 1920 as the steamship Panama, this vessel has had her name changed to Maine, after the pre-war hospital ship which was presented to the Royal Navy at the time of the South African campaign by a number of American ladies. The old Maine was launched at West Hartlepool in 1887, and was

315 ft. long by 40 ft. in breadth. The new ship is larger, being 400 ft. long by 52 ft. in breadth, and £225,435 is set apart for her in the Estimates. She was taken in hand for refit at Portsmouth in March, 1921.

### Warship Repairs.

A considerable part of the activity of the dockyards during the past year has been devoted to warship repairs, and in addition to the ordinary refits of ships, opportunity has been taken to effect many improvements in their structure or equipment in the light of the lessons of the war. The battle-cruiser Repulse was recommissioned on January 1, 1921, after being out of commission at Portsmouth since December 17, 1918. During that time she was thoroughly overhauled, and considerable additions made to her armour protection at a cost of about £860,684. The battleship Royal Sovereign, after being withdrawn from the Atlantic Fleet and reduced to three-fifths' complement, became tender to the Victory in May, 1921, while undergoing a long refit in Portsmouth Dockyard, during which opportunity was taken to fit her with the system of bulge protection. About the same time, the battle-cruiser Tiger, on being taken into dockyard hands for a refit at Devonport, had her boilers adapted for burning oil instead of coal. She was the last fighting ship in the Atlantic Fleet to be coal-fired. These various modernising processes should not be forgotten in estimating the efficiency of the existing Fleet in relation to those of other Powers. Although they cannot make up, of course, for any lack of ships, they indicate a determination on the part of the Board to maintain the material of the pre-war Navy, which it is necessary to retain for the present, in as high a state of efficiency and preparedness as possible.

### Naval Material.

Financial considerations early in 1921 obliged a continuation even of the heavy cutting-down process which had been in operation during 1919 and 1920, when an unprecedented number of warships were scrapped. The transfer to the disposal list of the eight early Dreadnoughts armed with twelve-inch guns—the Hercules, Colossus, Neptune, St. Vincent, Collingwood, Temeraire, Bellerophon, and Superb—left a total of capital ships on the effective list of 30, or 28 if the Australia and New Zealand are deducted. This gives a battle fleet not more than twelve years old from the year of authorisation, or eleven years old from date of launch, or ten years old from date of completion. While the Fleet, taken as a whole, however, is comparatively modern, it will be found on examination that practically the whole of it was built in the first half of the periods mentioned. The oldest ship is the Orion, completed in the late autumn of 1911, and therefore now ten years old. But if a dividing line be fixed at the corresponding period of 1916, it will be seen that 28 out of the 30 ships were built in the earlier half of the ten years, and only two, the Ramillies and the Hood, were completed during the five years 1917–21 inclusive. Hence the need for

the provision of four new ships towards making good the prospective wastage from ships becoming obsolescent, which will be very heavy within the next year or two.

As regards light cruisers, the Bristol class were already reduced to care-and-maintenance parties at the beginning of 1921, except the Glasgow, which was ordered to become stokers' training ship at Portsmouth in place of the Diadem. By May, 1921, they had all disappeared from the Navy List. The next class, the Dartmouth, Weymouth, and Yarmouth, were in process of being similarly dealt with, following their recall from South American waters. This leaves the Chatham class, of which the name-ship was launched in 1911, and the others in succeeding years, the oldest light cruisers in the Navy. They are at present utilised for foreign stations. There has been no further scrapping of destroyers or submarines after the drastic reductions referred to on page 13 of last year's "Annual."

On May 30, 1921, it was announced that there had just been concluded between the Admiralty and Messrs. T. W. Ward, Limited, of Sheffield, what was described as the biggest deal ever made for the breaking-up of obsolete warships. The firm bought, at a flat rate of £2 10s. per ton on actual displacement, 5 battleships, 6 cruisers, 6 light cruisers, 3 flotilla leaders, 72 destroyers, 13 torpedo boats, and 8 monitors—a total of 113 warships. The battleships were the Dreadnought and Magnificent, lying at Rosyth; the Hindustan and Dominion, at Chatham; and the Mars, at Invergordon. The cruisers were the Sutlej, at Rosyth; the Diadem and Achilles, at Portsmouth; the Cumberland and Edgar, at Queenstown; and the Devonshire, at Devonport. The light cruisers were the Bellona and Bristol, at Portsmouth; the Gloucester, at Devonport; and the Sapphire, Diamond, and Newcastle, at Chatham. The destroyers ranged from the Rattlesnake, Savage, and Scourge, of the "G" class, launched in 1910, to the Tristram, of the Admiralty modified "R" class, built in 1917; and the torpedo boats were all of the "coastal destroyer" type, with numbers ranging from No. 7 to No. 36, built in 1906–09. The monitors were the Abercrombie, General Wolfe, and Havelock, at Portsmouth; the General Crauford, at Chatham; the Mersey and Severn, at Queenstown; and the Prince Eugene and Roberts, at Immingham. In entering into this record contract, the Admiralty stipulated that the vessels should be handed over at intervals, and they reserved the right to withdraw any named in the list and to substitute other similar vessels if circumstances rendered that advisable. On July 1, 1921, it was announced that all the ships of the monitor class remaining in the Navy, with the exception of the two 15-in.-gun ships Erebus and Terror, were to be placed on the non-effective list, to be disposed of as opportunity permitted.

### Merchant Shipbuilding in the Dockyards.

The decision to order two 10,000-ton oil-tank vessels for naval use from the dockyards at Devonport and Pembroke was recorded last year. The names allotted to these vessels are the Olna and Oleander respectively. It will be noticed that the letters "Ol" are

adopted as a prefix, whereas in the pre-war oilers, like the Ferol and Carol, built at Devonport in 1913–14, they were used as an affix. In May, Mr. Amery stated that the approximate date for the completion of the Olna, which was launched on June 21, 1921, was September, 1921; and the Oleander, April, 1922. The former was begun, on the slip vacated by the cruiser Frobisher, on June 14, 1920; but the keel of the latter was not laid at Pembroke until December 1, 1920, owing to alterations having to be made to the building slip.

In addition to the above two vessels for naval use, the Admiralty also ordered two others, of 8,400 tons' capacity, to be built at Portsmouth and Devonport for the Anglo-Saxon Petroleum Company, on a system of repayment, as recommended by the Colwyn Committee in 1919. These vessels are to be named the Nobia and Nassa. The former was laid down in No. 13 dock at Portsmouth on April 19, 1921, when the ceremony of laying the keel-plate was performed by Lady Alexander-Sinclair, wife of the Admiral-Superintendent, and the Nassa was begun shortly afterwards. March, 1922, is the official date for their completion.

From Sunday, January 23, 1921, a system of "short time" was enforced in all the Royal Dockyards, and certain other naval establishments, to find employment for more men than would otherwise have been possible. The working week was reduced by seven hours, and wages accordingly. Instead of the 47-hour week previously in operation, the working hours were eight a day for five days, and from Friday night until Monday morning work ceased. Full time was resumed on October 1. A reference to this matter will be found in the First Lord's Memorandum, which is printed in the Naval Appendix.

## Oil Fuel Storage.

Presenting on May 24, 1921, the vote for works, buildings, and repairs at home and abroad, Commander Eyres-Monsell, the Civil Lord, dealt in the House of Commons with the oil policy of the Admiralty and its necessary commitments in regard to storage. He said that, at the moment, the Board were actually paying less money for oil than for coal, taking into consideration the respective calorific values. Further, where they had to handle three tons of coal they had now to handle two tons of oil, and the handling of oil was much easier than that of coal, since it could be carried by means of a pipeline, instead of by the most laborious process of filling coal, hoisting it on board, and putting it down into an almost inaccessible stokehold. Further, the efficiency of oil was very much higher than that of coal. For instance, to re-fuel destroyers, which burnt coal, they had to travel to some port and go through the laborious process indicated, but oil-burning destroyers had only to go alongside a battleship, and in two hours their stowage could be filled with oil. As to the smaller space required for oil stowage, "although that may seem a small thing, it is of vital importance to-day, when one of our greatest difficulties is that of fitting ships of ever-increasing size into existing docks, by which an enormous amount of money is saved."

Lastly, there was the large reduction in personnel in oil-burning as compared with coal-burning vessels.

Having shown that the oil-burning policy was not only a wise one, but the only one which the Admiralty could pursue, the Civil Lord went on to deal with the Works Vote, in which the biggest new expenditure was for oil storage. At home, an Admiralty reserve, authorised by the Cabinet in 1919, is being built up, to be completed in 1929, and to cost this year £958,000. Abroad, the provision is merely to meet the ordinary peace requirements of ships while cruising in foreign waters, the total accommodation for other purposes being reserved for consideration at the Imperial Conference. For storage at the Cape of Good Hope, £42,000 is provided; at the Falkland Islands, £10,000; at Gibraltar, £76,200; at Hong-Kong, £65,000; at Jamaica, £21,340; at Malta, £77,600; at Port Said, £43,650; at Rangoon, £50,000; at Sierra Leone, £10,000; at Singapore, £50,000; making a total of £445,790. In the course of the debate, Commander Eyres-Monsell dealt with the suggestion of keeping oil afloat in hulks, and said it was the most expensive form of stowage that could be imagined—for the cost of keeping oil in a tanker or ship for four years the necessary permanent tank could be built on shore. The matter of defence was raised, and the Civil Lord said that all sites for tanks were selected with the approval of the Imperial Defence Committee of the War Office, who were responsible for shore defence, and this Committee was satisfied that the tanks could be protected in the positions in which they were being placed.

## Revised Estimates.

Revised Navy Estimates, as regards Votes 8 and 9, and a supplementary estimate of £10,000 under Vote 10 (works), were ordered by the House of Commons on July 27 to be printed (No. 187). They showed that the revised total of the shipbuilding vote was £29,575,300, made up of £11,845,600 for dockyard personnel, £12,083,500 for dockyard material, and £5,646,200 for contract work. The total allotted to the four new armoured ships was, for hulls, £1,357,400, and for machinery, £426,947. The individual amounts varied from £529,980 for ship No. 1 to £359,144 for ship No. 4. For a submarine boat, to be built at Chatham, £228,337 was taken, and for a minelayer, at Devonport, £214,838. The sum of £111,031 was also taken for an additional section to the *ex*-German floating dock No. 8. The additional amount taken under the vote for works was required to provide for the commencement of an extension to the R.N. Torpedo Factory at Greenock, which, with the necessary land, is estimated to cost £54,000.

## Personnel.

More than half the Memorandum which followed the First Lord's Statement Explanatory of the Navy Estimates was devoted to matters connected with the personnel of the Navy, in regard to which there arose during the year many urgent problems for consideration and

decision. A period of retrenchment must naturally present difficulties in this connection, but when that period follows the vast expansion which occurred immediately before, and during the whole of, a war such as that of 1914–18, the difficulties are accentuated and multiplied, and like a cloud over all the deliberations of the Board has hung the acute financial stringency of the country, which has prevented the grant of funds which in normal times would have financed schemes to provide for, or assist in, the transition period from war to peace. The special retirement scheme to clear the lists, for example, is stated to have been taken advantage of by over 1,100 officers, but it is admitted that "the numbers borne now are still considerably greater than actual requirements." This matter will be referred to later. It is right to bear testimony, however, to the unfailing devotion to duty which continues to be shown by officers and men in a time when the outlook for them is far from bright. Mr. Walter Long, in his farewell message as First Lord, said that he could not sever his connection with the Royal Navy " without saying how profoundly I have been struck by the loyalty, efficiency, and keenness of all ranks of our great Service."

## Entry and Training.

The closing of Osborne as a college for naval cadets, referred to last year, took effect on April 9, when the last cadets left. On May 20, the college grounds and buildings passed under the charge of the Admiral Superintendent at Portsmouth. In May, 165 cadets from the last terms at Osborne were transferred to Dartmouth, bringing the total number there to 589. The College was built to accommodate 600 cadets, and during the war as many as 535 were in training there without inconvenience, so that no special difficulty was found in catering for the enlarged number, which, of course, will be automatically reduced at the end of each term in the immediate future. By May, 1922, it is officially stated, there will be about 480 cadets at Dartmouth. Captain Francis A. Marten, C.M.G., C.V.O., from Osborne, was transferred to the command of Dartmouth College in February, 1921. The commissioning of the Thunderer as a cadets' sea-going training ship has been mentioned; in this vessel will be concentrated all cadets' sea training, including that of paymaster-cadets.

A reference to the First Lord's Memorandum will show that the dividing line between deck and engineer officers has again been more clearly defined. As originally introduced in 1903, the common entry scheme, the principle of which remains in operation, provided that these officers should serve together as cadets, midshipmen, sub-lieutenants, and for about a year as lieutenants, before separating to their various specialist or non-specialist branches. Gradually, in the light of experience, this period before specialisation has been shortened. In March, 1920, midshipmen were being encouraged to volunteer for engineering after one year at sea, and were being given special engineering instruction after doing so. In March, 1921, the First Lord announced in his Memorandum that a still earlier

separation had been decided upon, to take effect immediately upon the completion of the four years at Dartmouth and the eight months in a training battleship. In other words, the future deck and engineer officers will be trained together only as cadets. As soon as they are rated midshipmen, those who wish to go in for engineering will, instead of going to sea as hitherto, proceed to Keyham for a three years' engineering course.

Measures have been adopted during the past year to remedy a shortage of specialists in certain branches, particularly in gunnery, which has followed upon the reductions in the rates of allowances to qualified officers which were a feature of the Jerram-Halsey revisions of pay in 1919. On November 27, 1920, the Admiralty selected twenty lieutenants and lieutenant-commanders who, on account of their previous service and confidential reports, were considered suitable, for a short gunnery course, which began in January, followed by a torpedo control course. On qualifying, these officers were to be eligible for appointment to certain posts formerly filled by fully qualified gunnery officers. On December 11, 1920, the Board announced that it had been decided to select forty more officers from among those whose courses for lieutenant were waived, and who had not volunteered to specialise in any branch, and to appoint them to the Royal Naval College at Greenwich, twenty in April, and twenty in October, 1921, to undergo the theoretical course for officers specialising in gunnery. This completed, the officers who were considered likely to be suitable were to be given the option of volunteering for the further course in the Excellent to qualify as Lieutenants (G); the others were to take a short gunnery course, like the twenty appointed for this purpose in January, 1921.

While the numbers of gunnery officers had decreased, the demands for them in the Fleet had increased. Accordingly, in December, 1920, "in order to increase the efficiency of the gunnery of the Fleet, and at the same time relieve the pressure of work devolving upon the gunnery officers of large ships," the Admiralty decided to appoint two gunnery officers to each capital ship. As qualified gunnery lieutenants were not likely to be available for some time, officers who had passed through the short course were to be appointed in lieu as they became available. The first vessel to have two properly qualified gunnery officers appointed to her was the Hood. As the First Lord has pointed out, the Navy has now become such a specialist Service that a very much larger proportion of officers are required to specialise than formerly, and it is estimated that 70 per cent. of the cadets must be prepared to join one branch or other to provide sufficient numbers.

### Training Courses.

The special courses of instruction open to deck officers, three at Greenwich and one at Portsmouth, which were described last year, are continuing their work, with certain modifications—the Senior Officers' War Course under Rear-Admiral H. W. Richmond, C.B.;

the Staff Course under Captain the Hon. Reginald A. R. Plunkett-Ernle-Erle-Drax, D.S.O.; the Intelligence Course under Major C. B. Mullins, R.M.L.I.; and the Senior Officers' Technical Course at the various schools at Portsmouth. The Technical Course and the War Course each take about twenty captains, R.N., in one session, the former being in the nature of a preparation for the latter. With the Technical Course beginning on April 4, 1921, the Admiralty ordered the time to be extended by one week, making nine weeks in all. Of the total of 45 full working days, 15 were to be spent in the Excellent, for gunnery instruction; 15 in the Vernon, for torpedo, mining, anti-mining, anti-submarine, and coastal motor-boat lectures; five in the Navigation School; seven in the Signal School, to include a lecture on D.C.B.'s, and a visit to the Physical and Recreational Training School; two at Fort Blockhouse, for study of the capabilities and endurance of submarines; and one, at the most convenient establishment, for lectures dealing with aircraft for naval purposes. The whole Course is intended to supply captains with the latest information as to the development of weapons and communications, and their employment, before being appointed to the War Course, or, alternatively, to a command afloat.

At the War Course, two sessions of which are held annually, in the spring and autumn, each lasting about four months, the principal subjects dealt with are strategy, tactics, and command, and the value of the instruction to the senior officers is manifest. If the full total of twenty captains attend each course, or forty in a year, it follows that there is ample provision for all captains to take the War Course soon after their promotion. The number of new captains made in 1920 was only twenty-seven, and in 1919, thirty-six. While on the subject of the Senior Officers' War Course, mention may be made of the excellent arrangement by which two captains, R.N., are permitted by the Army Council to attend the Senior Officers' School at Woking, where three courses are held each year. These vacancies are allocated by the Admiralty to captains who have not held a command afloat. Similarly, two officers of commander's rank are attached to each annual course at the Military Staff College, Camberley.

For the course for the training of War Staff Officers, a new session of which opened at the end of September, 1921, the Admiralty ordered in February that selection would in future, as a general rule, be confined to commanders, lieutenant-commanders (including those who reach this rank during the course), and marine officers under the age of thirty-four, but any officer may send in an application after reaching six years' seniority as a lieutenant. About thirty-six officers are chosen annually for this course. The Intelligence School, under Major Mullins, R.M.L.I., which is a branch of the Staff College, provides seven weeks' training in intelligence duties, and the maximum accommodation available is for a class of eight.

During 1921 the subject of anti-gas instruction in the Navy received increased attention and was organised on a more systematic basis. Officers and men have been sent regularly to undergo the $4\frac{1}{2}$ days' course provided in the Gas School, started under the direction of Lieutenant-Commander E. S. Brooksmith, D.S.C., at the gunnery

training establishment at Whale Island, Portsmouth. An arrangement was made by which, before a ship commissioned for foreign service, or before a draft was detailed, the executive officer, the medical officer, one petty officer, one non-commissioned officer, and one C.P.O. or P.O. from the stoker branch were to take the course. In addition, all medical officers serving on shore or in harbour ships in home waters were ordered to be lent to pass through the course, as well as officers and petty officers in harbour ships and establishments, as far as accommodation permitted. In July, 1921, the light cruiser Boadicea was appropriated as an anti-gas training ship at Portsmouth.

The Secretaries' Course, held in the old War College in Portsmouth Dockyard, has continued its work during the year under the direction of Paymaster-Captain A. R. Parker, C.B., as Superintendent, and Paymaster-Commander Reginald Butcher, C.M.G., M.V.O., as Assistant-Superintendent. Two courses are held annually, starting in February and August, and lasting four months. The accountant officers who pass are denoted by a dagger within brackets—[†]—placed against their names in the official Navy List. The provision for fees to lecturers at the Secretaries' Course was increased from £300 to £400 in the 1921–22 Navy Estimates.

## Pay and Allowances.

Only one or two minor concessions in the matter of pay have been granted to the Navy since the last issue of the "Annual." In November, 1920, a new special rate of pay for warrant officers was approved in order to remove various anomalies of pay under which these officers were labouring. It was represented to the Admiralty that, in certain cases, the warrant officers were in receipt of lower emoluments than they were receiving (or would have received under more recent scales) as ratings prior to their promotion. It was manifestly undesirable for several reasons that this state of things should continue, and accordingly a scheme of special rates was introduced with retrospective effect to January 1, 1920, the day following the abolition of children's allowance, to be applicable to all warrant officers serving on that date, irrespective of the date of their promotion. Any officer who could show that his total emoluments as a rating on the day preceding his promotion exceeded, or would under later scales have exceeded, his total emoluments as a warrant officer, was to be paid at a special rate, not exceeding the maximum applicable to his rank on the ordinary warrant officer's scale. The rate was to be calculated at such a sum as would make up a daily total equal to that received before promotion, and when the daily sum was not a multiple of 6d., it was to be made up to the next multiple of 6d. above.

A similar concession was announced in the House of Commons on December 16, 1920, for officers promoted to the grade of mate, R.N., before January 1, 1920. Mates and lieutenants (ex-mates), of the general service, signal, or wireless branches, were eligible for the increase authorised, but not those promoted after January 1, who, of

course, were aware of the post-war rates of pay before they were advanced to their new rank. The special rates were, for mates, 17s. a day, instead of 16*s.*; and for lieutenants (ex-mates) on promotion, 20*s.*, instead of 17*s.*; after four years, 22*s.*, instead of 20*s.*; and after six years, 25*s.*, instead of 24*s.* These increases did something to remove the anomaly between the pay of those concerned and the commissioned warrant and warrant officers who might be serving under them.

The question of granting a marriage allowance to naval officers, similar to that paid to married officers of the Army and Royal Air Force, was frequently discussed during the year, and was stated on more than one occasion to be under consideration by the authorities. The anomalous position in which married naval officers had been placed since the withdrawal of the children's allowance on December 31, 1919, was indicated by Rear-Admiral T. B. S. Adair, M.P., who said in a speech on March 18, 1921, in Committee of Supply on the Civil Service war bonus charges, that the Civil Service clerk who before the war was getting £182 10*s.* a year was now being paid £402 10*s.* a year, but the junior officer in the Navy who before the war was getting £182 10*s.* a year was to-day only receiving £292 a year, with a basic rate of only £270. It was also admitted by the Secretary of the Admiralty in reply to a question from Admiral Adair on May 11, 1921, that a lieutenant or lieutenant-commander, R.N. who was married was getting less pay than married officers of equivalent rank in the Army and Air Force. According to a correspondent in the *Times*, the total emoluments of a married lieutenant, R.N., were £310; of an Army captain, £584; of a lieutenant-commander, £547, and of a major, £729; and of a commander, £730, as compared with a lieutenant-colonel's £1,022. As late as August 8, 1921, Mr. Amery said that the Admiralty were giving the matter the closest attention with a view to finding some means of overcoming the difficulties that stood in the way.

It is satisfactory to record certain concessions made during the year in regard to pensions and allowances. On March 23, 1921, the Admiralty announced that the ordinary rates of pension for the widows of officers on the active retired lists, whose deaths occurred on or after August 13, 1920, had been increased. The pension for the widow of a commander, or officer of equivalent rank, was augmented to £90 a year; of a captain, £100 a year; of a first-class commodore, £120; of a rear-admiral, £150; of a vice-admiral, £187 10*s.*; of an admiral, £225: and of an admiral-of-the-fleet, £300. Reference to the old rates in the quarterly Navy List will show that they ranged from £60 to £120, so that the increase was a liberal one. On the same date, the Admiralty also announced the grant of servants' allowance to officers whose appointments obliged them to live on shore without the services, or partial services, of a servant provided at the expense of the Crown. Formerly, officers serving at the Admiralty, or forming part of the authorised complements of medical, educational, or civil establishments, whose pay was provided in Votes other than Vote 1 of the Navy Estimates (wages), were excluded from the receipt of this allowance. It will have been noted that the grant

of the allowance to them was responsible for a few minor increases in certain other votes of the Navy Estimates.

## Promotion and Retirement.

The special retirement scheme with the object of "reducing the surplus of officers resulting from the expansion necessitated by the war" was in operation from April 1, 1920, for a period of six months, except for officers serving on foreign stations, who were allowed six months from the date of the receipt of the Admiralty announcement on the station. Although upwards of 1,100 officers took advantage of the scheme, it did not serve to effect any reduction in the aggregate numbers, as the following figures show :—

| | Captains. | Commanders. | Lieutenant-Commanders. | Lieutenants. | Total. |
|---|---|---|---|---|---|
| April 18, 1920 . . . | 365 | 604 | 699 | 1,432 | 3,100 |
| October 18, 1920 . . | 363 | 573 | 595 | 1,277 | 2,808 |
| April 18, 1921 . . . | 364 | 574 | 585 | 1,616 | 3,139 |
| July 18, 1921 . . . | 359 | 581 | 569 | 1,621 | 3,130 |

Another indication of the fact that the lists were overcrowded was the Admiralty announcement of April 2, 1921, in regard to the matter of optional retirement at the age of forty. In July, 1919, at the time of the changes introduced as a result of the Jerram-Halsey report on officers' pay, optional retirement at forty was granted to all ranks of officers in the Royal Marines, and to accountant, medical and instructor officers, at Admiralty discretion, and it was ordered that this extension of the privilege to all branches would be reconsidered in eighteen months' time, with a view to some limit being placed on the numbers to be allowed to retire annually, if necessary, in the interests of the Service. On April 2, however, after more than eighteen months had elapsed, the Admiralty stated that voluntary retirements were still open, and they have remained so ever since, there being no need to impose yet any such limit as was anticipated in 1919.

A commendable practice adopted since the armistice, giving officers a better idea of their position and prospects of advancement, has been that of publishing the zones of promotion by which the Admiralty are guided in making the half-yearly selections. An order of September 29, 1920, fixed these zones as follow for the promotions to be made on December 31, 1920, and in future :— *Executive branch :* Commanders, 4½–8 years' seniority inclusive; lieutenant-commanders, 2–6½ years' seniority inclusive. *Engineer branch :* Engineer-commanders, 8 years' seniority and over; engineer lieutenant-commanders, 4 years' seniority and over. *Medical branch :* Surgeon-commanders, 8 years' seniority and over. *Accountant branch ;* Paymaster-commanders, 12 years' seniority and over. After the June, 1921, selections, the zone for engineer-commanders

was to be altered from eight years' seniority and over, to 8–11 years' seniority inclusive on the date of selection. Similarly, a curtailment of the zones in the executive branch was announced on February 23, 1921. In the June, 1921, selection, the zone for commanders was to be 5–8 years; and in the December, 1921, selection, 5½–8 years. For lieutenant-commanders in both selections, the zone was fixed at 3–6½ years.

### Uniform and Victualling.

A few changes in the uniform and clothing regulations were made during the year, generally with the object of simplifying the kits of officers and men and reducing expense. One interesting innovation, however, was the order of March 9, 1921, establishing armlets for Staff Officers in the Royal Marines. Those employed at the Admiralty were ordered to wear red, white, and red armlets with a gilt metal Tudor crown and a gilt metal anchor. In ¾-in. black cloth below the anchor, the letter "A" for officers on the General Staff, R.M., or "G." for those on the Naval Staff, was to be worn. Marine officers on the staffs of Commanders-in-Chief and Senior Naval Officers were to wear red armlets with gilt metal anchors, and the following letters in ¾-in. black cloth: Fleet R.M. officers, "R.M."; Intelligence, War Staff, and Base Intelligence officers, "G."; and Wireless Officers, "W.T." Brigade Majors at the Royal Marine Divisions and Depot were to wear a blue armlet with the letters "B.M." in ¾-in. black cloth. With the introduction of these various armlets, gorget patches were abolished for officers below the rank of Colonel-Second-Commandant.

As regards naval ratings, the most interesting change was the abolition of the sennet or straw hat, by an order dated March 16. At home, the uniform blue cloth cap was ordered to be worn, with the white cap cover in summer, on the occasions on which the sennet hat was previously worn, and sun-helmets by men serving abroad. With the passing of the sennet hat there was removed almost the last feature of the picturesque dress of the sailor as it existed for many years after the establishment of his first uniform in 1857. The dress then made official had, moreover, been the irregular uniform of British seamen for many years, and it was directly associated with the Napoleonic wars. In March also, chief petty officers and petty officers and men not dressed as seamen were permitted, by a new Navy Order, to wear blue waterproofs of the pattern formerly worn by officers, but without capes. It was also decided that white woollen gloves should be added to the optional kit of C.P.O.'s, and P.O.'s with over four years' service as such.

No change in the system of victualling was made, but various improvements, including some put forward through the medium of the Welfare Committee, were adopted in the arrangements for preparing and serving meals on board ship. These, which it is unnecessary to refer to in detail, included the provision of electric heaters in pantries for keeping meals hot; the supply of radiators in messes; the replacement of mess stools by padded seats with reversible backs; and similar innovations. These concessions were

ordered to be adopted in all battleships with 13·5-in. guns and later types, and in contemporary light cruisers.

### The Naval Reserves.

An important step since the last issue of the "Annual" has been the formulation of new conditions of service in the Royal Naval Reserve and Royal Naval Volunteer Reserve, to bring those bodies into line with the changes brought about by the war. The new scheme, as far as ratings are concerned, was published as a Fleet Order on March 9, 1921, and recruiting was reopened on April 1. The new regulations for officers were similarly published on May 25, 1921. As regards the former, R.N.R. ratings were to be enrolled for Fleet or Patrol Service, according to their civil occupation and personal inclination. A third class, for Shore and Harbour Service, was to be restricted to men who became unfit for sea service through age or physical disability. The R.N.V.R. was to be widened in scope so as to include representatives of all ratings in the Royal Navy, *i.e.* writers, motor mechanics, and the like, as well as seamen and signalmen. It was to be formed into Divisions and Sub-Divisions, the latter answering to present Companies. There were to be two categories of personnel, first, those belonging to Divisions and attending headquarters for instruction, such as seamen and signalmen; and secondly, those borne on Divisional Lists for administrative purposes, but not necessarily attending at headquarters for instruction, such as artificers, writers, and the like. It is neither necessary nor possible, as the Secretary of the Admiralty said in announcing the new scheme in Parliament, to maintain a permanent Reserve of sufficient size for all war requirements. The aim is rather to retain only a sufficient number to meet our needs on mobilisation and in the early days of war, and at the same time provide machinery for rapid expansion on the outbreak of war.

On November 3, 1920, it was announced that the King had approved of the appointment of Field-Marshal H.R.H. the Duke of Connaught, K.G., to be Honorary Captain in the Royal Naval Reserve; and of Major-General H.R.H. the Prince Arthur of Connaught, K.G., to be Honorary Captain in the Royal Naval Volunteer Reserve. These appointments identified members of the Royal House with the two Services at the time when, after rendering eminent and valuable assistance to the Royal Navy and the nation during the war, they were about to be thoroughly reorganised with a view to increasing their efficiency as Reserves for the Navy.

Under the new conditions of officers' training and service, the periods of training, both obligatory and voluntary, are increased to meet new conditions, and the courses remodelled to allow officers to specialise. An officer will perform the long periods of training and service as early in his career as possible, so that, in the case of a Mercantile Marine officer, they will least interfere with his mercantile service. The Admiralty expressed the hope that these changes will "not only bring the efficiency of the Reserves to a high level, and increase their usefulness in time of emergency, but will also

maintain in time of peace that close connection between the Reserves and the R.N. proper, which is an essential preliminary to their proper co-operation as parts of the same fighting machine." An important new provision is that officers of the R.N.R. who possess certain special qualifications will be allowed to rank, and, in the case of executive officers, take command with officers of the Royal Navy of corresponding rank, according to seniority, and not after all R.N. officers of the rank as at present. This privilege is also extended to "qualified" officers of the R.N.V.R. The new ranks instituted were:—R.N.R.: Commodore (formerly only in existence exceptionally), skipper-lieutenant, engineer-captain, engineer-commander, and paymaster-commander. R.N.V.R.: Commodore, engineer-commander, engineer lieutenant-commander, engineer-lieutenant, surgeon-captain, and paymaster-commander (substantive rank). Engineer ranks were introduced into the R.N.V.R. for the first time.

Good progress was made during the year with the Special Reserve of Royal Marines, established during 1918, and the number of which is at present limited to 100. This Reserve is open to officers who have held temporary commissions in the Royal Marines under the rank of lieutenant-colonel; substantive warrant officers and non-commissioned officers who were granted temporary commissions during the war; warrant officers, Class I., who on discharge to pension are recommended by their commanding officers as suitable to hold commissions in case of emergency; and gentlemen specially appointed from civil life who must have passed an Army or Marine entrance examination, or have a "leaving certificate," or have passed the Matriculation Examination of a University. All officers are required to undergo 14 days' training each year, and may also come up for voluntary courses not exceeding 42 days in any one year. The cost in 1921–22 is £4500.

The Special Reserve of Engineers, R.N., was established in January, 1920, from officers who held temporary commissions in the Royal Navy as engineer-lieutenants or engineer sub-lieutenants, acting mates (E.), and acting artificer engineers, R.N., other than those promoted from chief engine-room artificer (pensioner). All these officers do 14 days' training annually, or 28 days' every two years, and may volunteer for twelve months' temporary service in the Fleet. Those resident in Australia or New Zealand can, by an arrangement with the Dominion Governments, announced on January 29, 1921, perform their training in ships of the Royal Australian Navy or the New Zealand Naval Force, reporting to the Secretary of the Commonwealth Naval Board the date on which they desire to embark. A similar arrangement exists for those living in Canada to train with the Royal Canadian Navy. The cost of the Special Reserve of Engineers in 1921–22 is £18,000.

## The Welfare Committee.

The second series of Interport Meetings of lower deck ratings arranged in connection with the scheme of the Navy Welfare Committee, and held in July and August, 1920, came to an unsatisfactory

conclusion owing to misguided tactics on the part of certain of the men's leaders, whose conception of welfare work in a disciplined body like the Navy was totally erroneous and inconsistent. The Admiralty, however, have continued during the year to give effect to as many as possible of the requests put forward through the 1919 Conference. As from October 1, 1920, they introduced a system of fortnightly payments throughout the Service, as a temporary measure until the number of writers available was sufficient to cope with the increase of work involved by the institution of a weekly payment system. In February, 1921, owing to reports from Commanders-in-Chief abroad that fortnightly payments were not generally desired on foreign stations, it was decided to resume monthly payments, the Atlantic Fleet being regarded as a home station with fortnightly payments. In response to another request, an order was issued that "when infectious and contagious diseases occur in H.M. ships and establishments and it is not possible for various reasons to discharge these cases to hospital or ashore, commanding and medical officers are to take steps to ensure that efficient segregation is carried out." Another concession was the reprinting for exhibition on notice boards and the like of non-confidential orders affecting the personnel. On October 13, 1920, the Admiralty dealt at length with 14 class requests, mostly affecting the Royal Marines and Marine Bandsmen, several of which were granted in part or in full. Similarly, on February 23, 1921, the payment was announced of an allowance of 9*d.* a day continuously from the date of qualification to writer ratings qualified in shorthand, subject to their maintaining efficiency and requalifying every two years. Further concessions in regard to allowances to writers employed as captains' clerks were announced on March 9, and a month later the Admiralty published the procedure which has been adopted to give effect to the request made that the last year of pensionable service shall be served at the home ports. When ratings serving on foreign stations are nearing the date on which they will have but one year to serve to complete their time for pension, application for reliefs is to be made by Commanders-in-Chief. The ratings will be regarded as eligible for relief on the date on which they will have but one year to serve to complete time for pension.

It is also apposite to mention here the appointment, in December, 1920, of a Committee at the Admiralty to investigate and formulate definite proposals on the question of imparting to the men of the Fleet during their periods of service educational and vocational training to improve their prospects of employment in civil life after their discharge. Captain E. M. Bennett, O.B.E., was appointed Chairman of this Resettlement Committee, the other members being Instructor-Captain H. H. Holland, B.A., Deputy-Inspector of Naval Schools; Major H. N. H. Houghton, R.M.L.I., representing the Adjutant-General of Marines; Mr. A. H. M. Robertson, of the Admiralty Secretariat; Mr. Haig Mitchell, Ministry of Labour; and Paymaster-Lieutenant Duncan F. Forbes, R.N., as Secretary.

### Recruiting.

It may have come as something of a surprise to many people to learn from a reply of the Secretary of the Admiralty to a question in Parliament on November 24, 1920, that there was a temporary shortage of seamen in the Royal Navy. The chief causes of this appear to be that demobilisation was carried out rather too rapidly, while, on the other hand, there were post-war duties and responsibilities thrust upon the Navy which were unforeseen at the Armistice. During last autumn and winter, therefore, special arrangements were made to stimulate recruiting, and four channels of entry or re-entry into the Service were opened up, in addition to those ordinarily utilisable. The first of these was available for ex-petty officers and men, whether belonging to the Royal Fleet Reserve or not, who had completed ten years' or more pensionable service. These men were permitted to re-enter to complete time for pension, provided they could do this before attaining the age of fifty. Secondly, other ex-petty officers and men were allowed to re-enter as long as they were not too old to qualify eventually for the Royal Fleet Reserve gratuity and were desirous of doing so. To qualify for this gratuity, a total period of twenty years' service in the Fleet and the R.F.R. must be completed before the age of forty-five. Under a third new regulation, ex-petty officers and men, including special service seamen who had been passed into the R.F.R., could re-enter for two, three, four, five, or seven years. Formerly, only engagements for the two last-named periods were approved for continuous service men. The article of the R.F.R. Regulations which debarred special service men, and those discharged free, or on reduced terms, to join the Reserve, from rejoining the Navy except in special cases, was suspended. Fourthly, the Admiralty reopened as from September 1, 1920, the entry of youths between the ages of seventeen and eighteen, and block "E" of the Royal Naval Barracks at Devonport was set apart for their training. These youths were entered as boys, first class, and paid as such.

It was found necessary to place restrictions on the system of discharge by purchase from the Royal Navy. Early in December, 1920, the Admiralty ordered that this was to be permitted only in exceptional cases. Discharge by purchase, they pointed out, "cannot be claimed as a right, and may be granted or withheld in accordance not only with the merits of the case, but with the requirements of the Service at the time." After directing flag and commanding officers to make careful investigation of applications for discharge before forwarding them, the order defined compassionate cases—those in which it was clear that undoubted material hardship to a man's dependents would be involved by his retention in the Service. Free discharge was only to be allowed in those compassionate cases in which the necessary money could not be raised for discharge by purchase. Until further notice, moreover, no ratings, except for "specially urgent compassionate reasons," were to be spared from among the seamen (including signalmen and sailmakers), the sick-berth branch, the regulating branch, all ranks of

the Royal Marines, writers, victualling ratings, electrical and ordnance artificers, and plumbers.

Reference to the Navy Estimates will show that the total number of boys under training increased between March, 1920, and March, 1921, from 1,738 to 3,500, and in the artificer branch from 928 to 950. The instruction and employment of these greater numbers presented many problems, and at the end of February, 1921, the Board, in pointing out that a large number of boys and youths were about to leave the training establishments, referred to the difficulty in drafting them at once to sea-going ships. Vessels which had accommodation were ordered to receive boys in addition to their authorised complements. It was expected that the capital ships of the Atlantic and Mediterranean Fleets would be able to absorb the greatest number, but the light cruisers on all stations were to accommodate a certain proportion. If accommodation was not available for all the boys in sea-going ships, either as part complements or as supernumeraries, those remaining were to be sent to capital ships of the Reserve Fleet while awaiting draft. Under a later order, ships were to accommodate certain numbers of boys in addition to their complement—50 in the Queen Elizabeths, Royal Sovereigns, and similar ships, 65 in the Hood, 150 in the capital ships with 3/5ths' crews, and so on down to 10 in light cruisers. No additional boys were to be sent to ships on the East Indies Station on account of the climatic conditions there, and ships on foreign stations were, when possible, to send home an equivalent number of able seamen when the boys were received. On August 24, it was announced that the battleships Colossus and Collingwood were to be used as additional training ships for boys at Portland, Captain B. St. G. Collard, R.N., being appointed in command.

## THE YEAR'S WORK.

The work of administration described in the foregoing pages covers the period from August 1920, to August, 1921. During this time, as has been shown, the operation of demobilisation dealt with in last year's "Annual" has continued, but much more has been done in the way of readjusting the various branches of our naval organisation to the needs of a smaller Fleet. Gradually, the formation of a Naval Staff has made progress as a continually increasing number of officers have passed through the educational courses, and others have obtained experience in practical work both afloat and ashore. Largely, the year's work has been of an experimental character, carried out not only by the research organisations and the technical schools at the ports, but also by the Fleet at sea. With the conclusion of midsummer leave, the Fleets and Squadrons entered upon their busiest period of the year as far as sea cruising was concerned. The Atlantic Fleet proceeded to its northern bases, but did not visit *en route* any seaside resorts as in 1919 and 1920. In explanation of this, Admiral Sir Charles Madden said, in a letter to the Mayor of Torquay, "It is desirable that no official entertainments be offered to officers or men, since the recent industrial troubles have

delayed the exercise programmes of the Fleet, and it is necessary to devote as much time as possible to further them." From the First Light-Cruiser Squadron under Rear-Admiral Sir James Fergusson, the Dauntless, after taking part in the French naval celebrations at Havre and acting as guardship during Cowes week, was detached to convey to New York the bodies of the American naval airmen killed in the wreck of the airship R38, off Hull. The Second Light-Cruiser Squadron under Rear-Admiral W. S. Nicholson made a cruise into the Baltic; and visits to Dutch ports were made by the First Destroyer Flotilla, accompanied by Rear-Admiral Michael Hodges in the light cruiser Coventry. Cruises by the foreign squadrons were also made, and it is understood that others were arranged, but owing to the financial stringency and other causes, these were modified or omitted altogether. Apart from their training value, the importance of these cruises for showing the flag and upholding British prestige in parts where squadrons are not permanently stationed was thoroughly recognised by the Admiralty.

Although no great building programme has been begun, or could be in the financial circumstances, the fact that private establishments are to be given work tends to keep together the resources of the country both in men and plant for the production of ships and naval war material, in readiness for an extension of these if it should at any time become necessary. On the other hand, it has been indicated officially that the public establishments, when times are more propitious, will be brought up to the standard of effectiveness required of them. Meantime, reforms have been carried out in regard to the well-being of the personnel of the Navy which are highly significant. Altogether, as the foregoing pages show, much has been done during the year to lay a sound foundation for the post-war Navy. This, whatever else it may be, must certainly be Imperial in character, and the efforts of the Admiralty have been helped considerably by the discussions on naval defence which took place during the meeting of the Dominion Premiers at the Imperial Conference in June and July, 1921. On July 27, that Conference adopted the following important resolution :—

> That, while recognising the necessity of co-operation among the various portions of the Empire to provide such naval defence as may prove to be essential for security, and, while holding that equality with the naval strength of any other Power is a minimum standard for that purpose, this Conference is of opinion that the method and extent of such co-operation are matters for the final determination of the several Parliaments concerned, and that any recommendations thereon should be deferred until after the coming Conference on Disarmament.

There, for the present, the matter rests, but as Mr. Amery said in making public the foregoing resolution, it will be regarded in future years as an important landmark alike in the history of British naval policy and of the development of Imperial co-operation.

CHAS. N. ROBINSON.

# CHAPTER II.

## Foreign Navies.

### United States.

Since the "Annual" last appeared the United States Navy has come under new influence and control, and, though it appears certain that the execution of the great and varied shipbuilding programme of 1916 will not be arrested, it is impossible as yet to predict the fate of the further programme prepared by the General Board of the Navy or to indicate the lines of future policy. In the meantime provision has been made which—unless Congress refuses further supplies of money next year and the year after, which is unlikely—will render the United States in 1924 the first Naval Power of the world, judged on the basis of the number of armoured ships, their tonnage, and their armament. Mr. Harding succeeded Mr. Wilson in the high office of President, and reversed the latter's attitude with regard to the League of Nations. Mr. Edwin Denby is the successor of Mr. Josephus Daniels in the position of Secretary of the Navy; as Minister, like the First Lord of the Admiralty in England, he is responsible under the President for all the business of the Navy, but is dependent upon Congress for money appropriations.

The new President has made certain important statements bearing, directly or indirectly, upon shipping and the Navy. On his return from Panama in December, 1920, speaking at Norfolk, Virginia, he said he wanted to acclaim the day when America would be the most eminent of the shipping nations. "A big Navy and a big Merchant Marine are necessary for the future of the country. I believe in partial but not permanent disarmament, and I foresee the time when this will be realised, but until that time arrives, I want a Navy for America's defence that is equal to the aspirations of this country." When he was sworn in as President on March 4, Mr. Harding said America would not be entangled. She would promote peace and participate in any seemly programme to lessen the probability of war and reduce the burden of armaments, but if war were again pressed upon her, he hoped all America, body and soul, would be concentrated on national defence. He reviewed, on April 28, off Fort Monroe, Virginia, the Atlantic Fleet of fifty fighting ships with auxiliaries—when for two hours he witnessed the great Armada file by, with the old Iowa, type then of modern things, moving unmanned under wireless control from the Ohio; addressing officers and men on board the Pennsylvania, he said that he hoped they might never be called upon to fire a gun again, for the American Government was pre-eminently peaceful. He concluded:

"The United States does not want a thing that is not rightfully her own; we do not want any territory; we do not want tribute. But we do want what is righteously our own, and by the Eternal we mean to have it." But the President has stated that he seeks peace and not war. In June he solicited from Congress, in broad and general terms, an opinion favourable to world disarmament, and the House on June 30, adopted almost unanimously the amendment submitted by Senator Borah, which authorised the President to enter into disarmament negotiations with Great Britain and Japan. This is embodied in sec. 9 of the Naval Appropriation Act.

Mr. Daniels was Secretary during the long period of eight years, including the whole of the war and the inception of the great shipbuilding programme. He saw the personnel expand from 43,000 men to more than half a million, the officers from 3,161 to 32,000, the ships and vessels of all classes from 326 to 1,000 (over 2,000 during the war), and the appropriations from 142,000,000 dollars to 1,900,000,000 dollars. He underwent a notable evolution towards great naval expansion. Throughout his career in office he was subjected to much criticism—just enough, he said, to make "the job really interesting." Towards the termination of his secretaryship, he came into strong opposition to certain senior officers, including Admirals Sims and Fiske, largely upon matters arising from a conflict of opinion regarding the operation of civil control, and the conduct of the war. The Majority Report of the Senate Naval Committee (July 18) on Admiral Sims' charges, censured Mr. Daniels, as also Mr. Wilson and Admiral Benson, while the Minority Report stoutly defended them.

Mr. Denby, a lawyer by training, was very acceptable to the Navy as a successor to Mr. Daniels, and more especially so to the Marine Corps, in which he had been embodied. He had had the unique experience of serving in two wars as an enlisted man. In the Spanish-American War, he joined the Naval Militia of Michigan, attained the rating of gunner's mate, and saw service in Cuban waters. In May, 1917, he enlisted in the Marine Corps, underwent recruit training, qualified as a sharpshooter, lectured to recruits, received a commission, acted as an observer in France, and retained his rank of Major until the summer of 1919. He entered upon his duties as Naval Secretary by working early and late, taking counsel with many congressional and other advisers—though declaring himself against political influence and wire-pulling—and meeting the Bureau chiefs at the customary weekly conferences of the Navy Department Council in prolonged sittings. On one occasion a conference on the Naval Appropriation Bill lasted until after midnight, and was resumed on the next morning, when Mr. Denby expressed himself as heartily in agreement with the addition of 100,000,000 dollars by the Senate Committee to the estimates as they had left the House of Representatives. He confirmed certain appointments, but showed his independence in the case of the Paymaster-General, over whose office a very heated contest had arisen, by selecting, during his visit to the Fleet, without the advice of politicians, in lieu of a rear-admiral, a captain who had not been in the running, but who was in

touch with the fighting services. He paid a visit to the Fleet in the West Indies and had a very strenuous time in making acquaintance with many naval necessities and learning the situation with regard to the personnel.

## Naval Administration.

The system of administration in the United States Navy possesses great flexibility, and is on a much better footing than during recent years. Under the President, the Secretary is supreme. The "Naval Aids" have disappeared, and the Secretary has now at his elbow the Navy Department Council, which holds frequent meetings. This Council possesses great importance. It was instituted in 1915 and gained experience in the course of the war and during the elaboration of the shipbuilding programme. It now brings the Secretary and Assistant Secretary into regular conference with the Chief of Naval Operations and the Chief of the Department of the Personnel (the latter under the name of Bureau of Navigation) and also with the Chiefs of the Bureaus of Construction and Repair, of Engineering, of Supplies and Accounts, of Yards and Docks, of Ordnance, and of Medicine and Surgery, and with the Commandant of the Marine Corps and the Judge-Advocate-General. Mr. Daniels said, in his last report, that this Council of the most experienced advisers had proved, during the war and demobilisation, of such value that it was regarded as a firmly established part of the departmental organisation.

The Chief of Naval Operations, Admiral Robert E. Coontz, is the most important naval officer in the administrative machine. He is more or less analogous to the First Sea Lord of the British Admiralty, though he is not the acknowledged head of the Naval Staff. His position was instituted by Congress in 1915, and has stood the test of war. The Chief has large statutory powers under the Secretary, and is in direct relation with Admirals in Command. He is head of the General Board of the Navy, by which large questions of naval policy are discussed, and has a staff of trained officers working with him, who are employed in studying and making plans for war, and for the operations of the Navy in peace. He has frequent conferences with the Bureau Chiefs, and is concerned with naval intelligence, communications, the personnel, higher education, and the study of naval strategy at the War College. There is no phase of naval study or activity with which he is not in touch and for which he is not held responsible under the Secretary, whom he constantly advises. The late Secretary of the Navy, in his last official report, gave expression to his reliance on the Chief of Operations. "His position is one of thinking, of planning, of leadership, of co-operation, with all the needed executive power that makes for the operation of the Fleet in peace and in war at the highest degree of efficiency. The Office of Operations under its chief had stood the test of peace in the preparation for war, and it has more than stood the test of war in the greatest naval expansion and operation in history." The system, he added, had proved its worth in the days of naval demobilisation and naval readjustment in the period after the war.

The position of the General Board of the Navy, of which the Chief of Operations is now *ex-officio* acting president, is sometimes misunderstood. For seventeen years after its institution in 1900, the Board was under the presidency of Admiral Dewey, who was succeeded by Admiral Charles J. Badger, "one of the wisest and ablest naval officers and statesmen," said Mr. Daniels. The members of the Board are all officers of rank, long experience, and high standing, but they possess no executive powers, and exercise a function that is purely advisory, though under President Roosevelt's administration there was a plan for converting the Board into a General Staff. It has now no statutory existence. "It is an invaluable body of advisers," having *ex-officio* members. In addition to the Chief of Operations, are the President of the Naval War College, the Director of Naval Intelligence, the Commandant of the Marine Corps and four or five others, constituting a working committee. Some of the duties which fall to the General Board in the matter of planning operations have been entrusted officially to the Chief of Operations, and the Board now advises on large questions of policy as an impartial consultative and deliberative body. Under direction of the Secretary it worked out the details of the three years' programme of construction, before the United States entered the war. The members of the Board participated in the conference between the Secretary of the Navy and British and French naval officers, when plans were prepared in Washington which secured the complete co-operation of the Allied and Associated Navies during the war. The Naval General Board, though in one sense unofficial, possesses great authority. Though some of its former duties now doubtless fall to the Bureau Chiefs assembled at the Navy Department Council, it still deals with the larger matters, has expressed its judgment on the question of big ships *v.* submarines and other problems, as will be seen below, and has elaborated on reasoned grounds a further shipbuilding programme. It may be observed, however, that the full recommendations of the Board on the shipbuilding programme have very rarely been adopted.

### "Power lies here."

The system of administration has recently been the subject of attack, not on grounds of its general character, but of the supreme position of the civilian secretary. Mr. Daniels contended that the Bureau system, founded on the principle that authority and responsibility cannot properly be separated, had been successful from 1842 up to the present time. He made a tremendous fight against the dominance of naval control, recalling the words of his predecessor, Mr. Meyer, when the latter pointed to the Secretary's desk, saying, "Power lies here and should remain here." He declared Admiral Sims' object, and the object of those who thought with him, was to curtail the power of the Secretary. They would create a General Staff in control, interposed between the Secretary and the Bureau chiefs. This, declared Mr. Daniels, would be fundamentally wrong. They wanted "a figure-head Secretary." "We want a rubber

stamp; we want a man to sit back and sign his name 'here' and have no authority." In the late Secretary's view, if ever authority were given to naval officers to control all the activities of the Navy Department, the next thing they would want would be "to oust the civilian Congress from control and put a von Tirpitz in control of the Navy, and a Ludendorff in control of the Army; and I would fight it if I were the only man alive, on principle, to the end of time, and when it is done, Americanism is ended in our Government!"

Whether Mr. Denby holds the view thus expressed so vigorously and characteristically remains to be seen. Probably "naval control" never really implied so great a constitutional change as the late Secretary feared. Evidently the Chief of Operations, though responsible to the civil authorities of the State, and having no sole responsibility of his own, has been invested by Congress with all necessary powers, and is, in effect, Chief of the Naval Staff. He has officers working with him in the Planning Section engaged in Staff duties, especially in preparing plans for the operations of the Fleet in peace and war. He is also in close touch with the Bureau Chiefs. Quite apart, therefore, from the question of final authority and responsibility, which is likely to be settled in the United States as it has been in this country, the system presents great advantages, inasmuch as it brings together selected officers of practical sea experience to elaborate plans of operations, in close association with the officers and officials whose function it is to provide means for giving effect to them. Admiral Coontz, as Chief of Operations, was stated by Mr. Daniels to have shown wisdom, resource, initiative and ability to lead in the wise operation of the Fleet and the attainment of greatly increased efficiency.

## Future Naval Policy.

The General Board of the Navy, by the very weight of its authority, undoubtedly influences Congress and the Nation. It expressed its views upon the subject of the suggested "naval holiday." Through Rear-Admiral Badger, it declared that it would be unwise and dangerous for the United States to adopt a policy of disarmament or limitation of armament in advance of the other nations of the world. When such a policy is put into effect it should bind all alike and not put America in a position of inferiority, from which, by the terms of the agreement, she could not extricate herself. The Board was in agreement with the Senate Naval Committee in supporting the completion of the 1916 programme. The latter said in its report: "For one nation to leave itself exposed to attack while another is preparing all the engines of war would be not only folly, but the greatest danger to the peace of the world that could be imagined. We earnestly hope that an agreement may be reached among the nations for a general reduction of armaments, but, at the present moment, universal disarmament has not been established, and the United States cannot leave itself undefended if it is threatened from any quarter. To do so would be a wrong to the American people and no service to the cause of peace."

On the subject of the future shipbuilding programme, the Naval General Board has made an important recommendation. In the last "Annual" (p. 43), its plan for a new programme to be initiated in 1921 was described. This took no effect, and the scheme now extends from 1922 to 1924. The programme is necessarily provisional, and must depend upon the possible establishment of international agreements. Nothing has occurred to alter the Board's opinion of the vital importance of the battleship—the ship that can give and take "heavy blows." The Navy Department has taken the same view. Developments of the past year, it declared, had confirmed the conclusions of the Department that battleships were still the backbone of the fighting fleet, and that this was no time for their abandonment. The deferred completion of the 1916 programme, due to the war, had caused an apparent congestion in construction, but the General Board contended that, in order to maintain the prospective fleet of twenty-one modern battleships, it would be necessary to consider the subject of replacement ships. Accordingly, as part of a further programme, the Board recommended that three additional battleships be laid down, one in each of the years 1922, 1923, and 1924, to be completed by 1927. It considered that the value of the battle-cruiser had been demonstrated, and said that the accepted policy in other maritime countries was to build a greater proportion of battle-cruisers to battleships than the United States had contemplated. The six American battle-cruisers will not be completed until well on in 1923, and others, it was urged, should be begun, but financial considerations moved the General Board to advise the laying down of only one additional, and that in the year 1923. With regard to light cruisers, the Board said the need of a large number could not be too strongly stated. The ten now in hand would be by no means sufficient. Other Powers were building vessels of about 5,500 tons, but the Board would not advise imitating them. It would go straight on to the building of cruisers of 10,000 tons, with high speed, heavy armament, and long cruising endurance in all weathers. It counselled that ten of this class should be laid down in each of the financial years 1922, 1923, and 1924. For China service four efficient gunboats were urged. Flotilla leaders, more powerfully armed than destroyers, better equipped for signalling, range-finding, and radio work, it was added, were also required, and six should be laid down in the same years with the light cruisers. At present the United States Navy possessed no such vessels. Destroyers were sufficient in number, but in each of the years 1922–1924 two submarines of a cruising type and four mine-laying submarines should be put in hand.

With regard to naval aircraft, the General Board and the Chief of Operations have taken wide views. They would devote considerable sums to experimental work on a large scale, but would not, at present, recommend more than a one-year programme. No one could foresee what the final *rôle* of aircraft would be, but the possibilities were great, and a Navy well skilled in the use of them, and well provided with modern types, would have great

advantages over a Navy not so trained and supplied. At present, funds available for naval aviation purposes are administered through the Planning Section of the Office of Naval Operations, but a Bureau of Aeronautics is to be established, for which Congress has recently made provision under sec. 8 of the Naval Appropriation Act. Aircraft carriers, a development of the war, to carry 'planes in considerable numbers, and from which aircraft can fly and to which they can return, are regarded by the Naval General Board as essentially fighting ships belonging to the Fleet, and in no sense as auxiliaries. It is claimed that they are needed as soon as possible, and it was recommended that four should be laid down in the years 1922–1924. Meanwhile, the first American aircraft carrier is the Langley (ex-collier Jupiter), which carries thirty-four 'planes of various types, and has a good flying-off deck and gear for hoisting in 'planes. Another, the Wright, 14,240 tons, four 5·5-in. guns, has been converted from a merchant vessel.

The following table summarises the recommendations of the General Board, dated Sept. 20, 1920:—

| | Financial years. | | | Total. |
|---|---|---|---|---|
| | 1922. | 1923. | 1924. | |
| Battleships | 1 | 1 | 1 | 3 |
| Battle-cruisers | — | 1 | — | 1 |
| Cruisers | 10 | 10 | 10 | 30 |
| Gunboats | 4 | 2 | 2 | 8 |
| Flotilla Leaders | 6 | 6 | 6 | 18 |
| Mine-laying Submarines | 4 | 4 | 4 | 12 |
| Cruising Submarines | 2 | 2 | 2 | 6 |
| Aircraft Carriers | 2 | 1 | 1 | 4 |
| Destroyer Tenders | 1 | 1 | 1 | 3 |
| Submarine Tenders | 1 | 1 | 1 | 3 |

## Naval Appropriation Act and Capital Ships.

The Naval Appropriation Act, which provides funds from July 1, 1921, onward for a year, was approved by the President and became law on July 12. The gross sum, as shown in the analysis published in the Appendix, is £84,352,204, including £18,493,784 for new construction, under the head of "Increase of the Navy." No naval financial measure in recent years has passed to and fro so many times between the House and the Senate. The total figure of over 400,000,000 dollars, is 14,000,000 more than was originally voted by the House, but 84,000,000 dollars less than the Senate had wished to authorise. The only really important measure is the provision for the new Bureau of Aeronautics within the Navy Department. There was a considerable fight over the vote for new construction. Finally it was provided that "no part of this appropriation can be expended except on vessels now being constructed." This stipulation will not affect any of the battleships, battle-cruisers, or scout-cruisers of the 1916 programme. Great progress has already been made with the destroyers and submarines of the programme, and not many will

be retarded, only about twelve of the former and seven of the latter being affected. The Senate made a great effort to get the submarines and a transport excepted, but its motion was lost. It also failed to include two additional seaplane carriers, but this proposal is to be considered under a Supplementary Bill. The Senate also lost its Pacific coast projects.

Here it may be noted with regard to capital ship construction, that the views of the Navy Department on submarine attack and the battleship *v.* aircraft question, already alluded to, were confirmed by the commission of naval and military officers who carried out bombing tests with the *ex*-German ships U 48, 117 and 140, Frankfurt, and the Ostfriesland. The conclusion was that the aeroplane, "instead of furnishing an economical instrument of war leading to the abolition of the battleship, has merely added to the complexity of naval warfare." In this unique series of trials, the Iowa, under wireless control, steaming at 9½ knots under her own power, and answering immediately to about a hundred radio signals, was also subjected to bombing experiments. The conclusion was as stated.

## THE THREE YEARS' PROGRAMME.

The features of the 1916 programme—including ten battleships (16-in. guns), four of the "Maryland" and six of the "North Carolina" class—were indicated, and the ships described in the "Annual" 1920–21 (pp. 44–46). The California (14-in guns), belonging to the anterior programme, has now been completed. Also anterior to that programme, or apart from it, are about fifty destroyers, twenty submarines, and certain fleet tugs, which were in hand on January 1. The Maryland, first of the new class, mounting 16-in. guns (8), was commissioned in July, 1921. The Colorado, a sister ship, was launched at the Camden yard of the New York Shipbuilding Corporation, on March 22, and the Washington, by the same company, on September 1. The last of the class, the West Virginia, is now well advanced. The six others (mounting twelve 16-in. guns in four turrets) are in earlier stages, but all are expected to be completed by 1924. The production of 16-in. guns for these ships is proceeding rapidly, and they are being delivered by the contractors at the rate of about three per month, in advance of the contract dates. The Government Naval Ordnance Plant at Charleston, W. Va., is furnishing the 6-in. gun forgings for the secondary armaments to the Naval Gun Factory at Washington so satisfactorily that these two establishments will be able to deal with practically all the 6-in. gun construction, and, when the Charleston plant begins to produce forgings for the 16-in. guns, they will be able to take over most of the big gun construction. Turrets and gun mountings have been supplied for the Maryland, and contracts have been placed for those of all the other battleships. The six battle-cruisers of the "Lexington" class are making progress, but are all in comparatively early stages, the Saratoga being furthest advanced, by the New York Shipbuilding Corporation.

Considerable changes have been made in the ten light cruisers of

the programme, with the object of adding to their fighting power, and strengthening their hulls to resist girder strain. The designs show that the cruisers are like big destroyers, with pronounced sheer and a lift towards the bows. They have four funnels and two masts, of which the forward one, carrying a director fire station, is a tripod on the British plan. Originally the armament was to have been of eight 6-in. guns with two 14-pr. A.A. and two 3-prs. Four additional 6-in. guns have now been added, mounted in two twin turrets. Some modifications of design have been involved by the change. The normal displacement of 7,100 tons has been increased to 7,500 tons, and the mean draught from 13 ft. 6 in. to 14 ft. 3 in., while speed has been sacrificed by a reduction from 35 to 33·7 knots (estimated). The names chosen are Omaha (launched December 14, 1920), Milwaukee (launched March 24, 1921), Cincinnati, Raleigh, Detroit, Richmond, Concord, Trenton, Marblehead, and Memphis. The system on which these cruisers are being built is to pay the actual cost to the contractor with a determined surplus or fee in addition. Five of the cruisers are to be completed this year. The others, which are progressing very rapidly, were authorised March, 1917, and July, 1918. The Trenton, Marblehead, and Memphis are least advanced. The intended complements were 19 officers and 337 warrant officers and men, but additions will presumably be required owing to the increased armament.

The statement on the next page shows the distribution of, and progress made with, the ships now under construction in the United States.

## New and Obsolescent Ships.

It has long been, and still is, the custom of the United States Navy authorities to retain in the lists of ships, many which have advanced more or less on the road to obsolescence, or, as Americans say, to the "junk-pile." This has never implied dependence upon anything other than high efficiency, but now a classification is in force which indicates the relegation of ships and vessels to an obsolescent category. This system, which is comparatively recent, is at the root of the reorganisation and redistribution of the personnel. Hitherto the battleships have been classified descriptively as of "single calibre" and "mixed calibre" (*i.e.* Dreadnoughts and pre-Dreadnoughts), and the cruisers under the designations of "battle-cruisers," "armoured-cruisers," and cruisers of first, second, and third classes. Now all are classified either as belonging to the "first line" or "the second line," with letters to indicate class designations, as shown within brackets below. The first-line battleships (BB) 27 in number, built and building, are all big-gun ships, and there were 21 second-line ships (OBB), the oldest being the Oregon, which ended her service in June, 1919. All the second-line battleships are likely to be sold as opportunity offers. At the time of writing, 17 remain in the list, the Wisconsin, Maine, and Missouri having been disposed of. Vessels of other classes will follow to the sale list. The existing monitors are all of the second line (OBM), and

| Type and name. | Contractor. | Per cent. of completion, July 1, 1921. Total. | On ship. |
|---|---|---|---|
| *Battleships (BB)* | | | |
| Colorado | New York S. B. Cpn. | 75·4 | 73·5 |
| Maryland | Newport News S. B. & D. D. Co. | 99·5 | 99·3 |
| Washington | New York S. B. Cpn. | 67·3 | 60·8 |
| West Virginia | Newport News S. B. & D. D. Co. | 57·0 | 48·2 |
| South Dakota | New York Navy Yard | 32·2 | 25·7 |
| Indiana | New York Navy Yard | 29·8 | 22·7 |
| Montana | Mare Island Navy Yard | 26·1 | 17·3 |
| North Carolina | Norfolk Navy Yard | 35·8 | 26·6 |
| Iowa | Newport News S. B. & D. D. Co. | 26·3 | 22·6 |
| Massachusetts | Beth. S. B. Cpn. (Fore River) | 8·6 | 3·0 |
| *Battle-Cruisers (CC)* | | | |
| Lexington | Beth. S. B. Cpn. (Fore River) | 21·1 | 12·3 |
| Constellation | Newport News S. B. & D. D. Co. | 11·5 | 9·0 |
| Saratoga | New York S. B. Cpn | 24·2 | 15·4 |
| Ranger | Newport News S. B. & D. D. Co. | 2·0 | 0·8 |
| Constitution | Philadelphia Navy Yard | 9·2 | 5·7 |
| United States | Philadelphia Navy Yard | 9·2 | 5·2 |
| *Scout-Cruisers (Light Cruisers CL)* | | | |
| Omaha | Todd D. D. & Const. Cpn. | 93·0 | 84·7 |
| Milwaukee | Todd D. D. & Const. Cpn. | 90·5 | 82·1 |
| Cincinnati | Todd D. D. & Const. Cpn. | 84·4 | 77·0 |
| Raleigh | Beth. S. B. Cpn. (Fore River) | 59·7 | 41·5 |
| Detroit | Beth. S. B. Cpn. (Fore River) | 59·8 | 41·6 |
| Richmond | Wm. Cramp & Sons Co. | 67·0 | 45·0 |
| Concord | Wm. Cramp & Sons Co. | 64·0 | 42·0 |
| Trenton | Wm. Cramp & Sons Co. | 47·0 | 30·0 |
| Marblehead | Wm. Cramp & Sons Co. | 45·0 | 27·0 |
| Memphis | Wm. Cramp & Sons Co. | 39·0 | 24·0 |
| *Auxiliaries* | | | |
| Fuel Ship No. 18, Pecos | Boston Navy Yard (Oiler AO 6) | 97·2 | 97·0 |
| Repair Ship No. 1, Medusa (AR 1) | Puget Sound Navy Yard | 63·6 | 48·1 |
| Dest. Tender No. 3, Dobbin (AD 3) | Philadelphia Navy Yard | 64·8 | 64·5 |
| Dest. Tender No. 4, Whitney (AD 4) | Boston Navy Yard | 28·9 | 21·9 |
| Sub. Tender No. 3, Holland (AS 3) | Puget Sound Navy Yard | 20·2 | 4·2 |
| Aircraft Tender, Wright (AZ 1) | Tietjen & Lang | 80·0 | .. |
| *Patrol Vessels* | | | |
| Gunboat No. 22, Tulsa (PG 22) | Charleston Navy Yard | 69·2 | 50·5 |

In addition there are under construction 5 destroyers, 5 fleet submarines, and 37 submarines.

Authorised but not under construction or contract 12 destroyers, 1 transport, and 7 submarines.

the only first-line cruisers are the 6 new battle-cruisers (CC). In the light-cruiser lists the Birmingham, Chester, and Salem have been relegated to the second line (OCL), the 10 new vessels building and

completing filling the first list (CL). The destroyers are classified in the same way: first line (DD), 284, built and building; second line (ODD), 21; and so also the submarines, 94 of the first line (SS), with 12 fleet submarines (SF)—6 not contracted for to date—and 48 of the second (OSS). There are 14 new light mine-layers, really destroyers (OM). Of the "Eagle" patrol vessels (PE), built for the war, there are now about 60, carrying two 4-in. guns and one 3-in. high-angle piece. During the war, 341 submarine chasers (PC) were built for the United States Navy, in addition to 100 for France, but some were lost, others have been sold or transferred to other departments for various services, and a large number have been placed on the sale list, so that now about 100 remain.

All submarines prior to the "O" class are assigned to the second line. The "O" boats, authorised in 1915, have all been in commission. Their extreme length is 172 to 175 ft., but the beam of the earlier boats is 18 ft., reduced in the last six boats of the class to 16 ft. 4 in. The surface speed is 14 knots (estimated) and the submerged speed from 10·5 to 11 knots. These boats have one 3-in. 23-calibre gun, and four torpedo tubes. Eight torpedoes are carried. There are 2 officers and 27 men. The R class are similar, and have the same complement. The length is increased to 186 ft., the beam to 18 ft., and the displacement to 569–680 tons, but the speed is reduced to 13·5 and 10·5 knots. The torpedo armament is the same, but the gun is more powerful, being increased to 50-calibre length. All these boats were completed and commissioned in 1918–1919. Of the 51 boats of the "S" class particulars are not available. Some of these have been in commission, and all the rest are in hand, many of them lauuched, at the Portsmouth, N.H. Navy Yard, and at Quincy (Fore River Co.), Bridgeport, Conn. (Lake Torpedo Boat Co.), and Quincy (Bethlehem Corporation), and at the San Francisco Yard of the same concern. In addition, are three powerful "T" boats originally designated AA., which are fleet submarines, all completed, and nine others of analogous class, V 1 to 9. Three of these are to be built at Portsmouth Navy Yard. Contracts for the others have not been made at the time of writing.

## Personnel of the U.S. Navy.

In the "Annual" 1920–21 (pp. 47–48) an account was given of the painful situation which had arisen with regard to the personnel of the United States Navy. The Navy passed through a most difficult time, but the problem of manning has, it is said, now been solved. On demobilisation, not only were hundreds of thousands who had enlisted for the war discharged, but also thousands of the regular line, including large numbers of skilled ratings. Many were unwilling to continue, and re-enlistment was slow until last year Congress, after urgent representations, granted an increase of pay. The new ships were coming forward just as men were going off the lists, and efforts were made to attract men and boys by means of an intensive recruiting campaign. Summer schools for boys,

centred at the Great Lakes and elsewhere, brought many into the Fleet; the advantages of foreign cruises were advertised; trade schools were instituted; and the better pay, and allowances in supplement, proved a great stimulus; the States of Tennessee and California were urged to provide for the manning of the battleships which bear their names; and short-term enlistments were authorised. At the beginning of January there were in the Navy over 120,000 enlisted men, and it was hoped to complete the full strength to the then authorised number of 143,396, but the Naval Appropriation Act reduced the number to 106,000, including 6,000 for aviation. In view of the transitional character of the period, the Naval General Board refrained from making any proposals, beyond a recommendation, in general terms, that men should be provided for the new ships. The Navy Department insisted that a wholesale reduction would be crippling to the service, and the Senate Naval Committee took up the matter, it being assumed that 120,000 enlisted men would be the minimum. These numbers, it should be observed, are exclusive of officers and warrant officers and of the whole Marine Corps. The greatest difficulty of all has been in replacing the skilled ratings, but much has been done by intensive training and drafting men to sea-going ships.

Mr. Denby, the new Secretary, approved the complement as adopted by the Senate of 120,000 enlisted men (with 24,000 Marines) rather than hold out for the authorised strength of 143,000. He announced that, because of the financial condition of the country, he would be satisfied with the number proposed notwithstanding the great needs of the Fleet during the next year and a half. It became increasingly evident that any number less than 120,000 would not suffice, and in order to put the newer vessels in commission, it would be necessary to place others in reserve. It was estimated that nearly 40,000 men would be discharged in the coming financial year, of whom nearly 12,000 went out in July and August. For that reason it was held that it would be disastrous to reduce the force as it has since been reduced by the Act. Recruiting was started by the curiously named Bureau of Navigation—which is the Department of the Personnel—on a limited scale, with a quota of 500 men a week, in specified ratings only.

Figures were supplied by the Chief of Operations, Admiral Coontz, to the Senate Committee explaining the necessity of providing 120,000 enlisted men. They showed the approximate proportion which the total personnel bears to the numbers actually available for the Fleet, and the proportion of the latter to the complements of different classes of vessels. The plan adopted was to take the ships considered necessary to constitute the active Fleet and then to allocate to them the number of men required to render them efficient. Admiral Coontz declared that with forces on a basis of 120,000 men, only 80,000 would be available for seagoing vessels. Then followed 27 categories of ships, the largest total for one class being 15 battleships needing 19,789 men, and two battleships for flagship duty with reduced crews, 1,800 men. Just over one-fourth of the Fleet personnel therefore, is required for battleships.

The 122 destroyers in full commission need 13,908 men, but the 87 submarines only 2,562.

In addition to the ships and vessels actually in commission or ready for service, the Department has to take account of the situation which will exist when the new ships come into commission, and of changes in organisation and tactics which mean additional men. The reduction of men precludes the possibility of "developing destroyer tactics to the extent planned with the Navy at full legal strength, 143,000 men," besides affecting essential shore activities, such as aviation and wireless communications. Admiral Coontz stated that it would be necessary to put out of commission during the coming year six battleships and certain cruisers in order to provide for the commissioning of the Maryland and Colorado and other vessels, including the first of the light cruisers. Then, again, 29 submarines were due for delivery. To man them, and provide 1,805 additional men for tenders, certain destroyers would be forced out of commission. In relation to this, the Admiral pointed out that while an effort would be made to keep them in a satisfactory condition, vessels out of commission are subject to rapid deterioration. The more of them there are, the greater the strain on the dockyard facilities.

An important factor which affects the personnel of the American and of other Fleets, is the ceaseless scientific progress in war material. The war involved great additions to the complements of ships, especially for duties connected with fire control, wireless telegraphy and the like. In American battleships, for example, the wireless stations have been increased from one to five, and the development of aircraft has resulted in the installation and manning of additional guns, while auxiliary vessels for Fleet duty require larger mechanical staffs, and there are other demands. In this way the Chief of Operations indicated the harm that might be done to naval efficiency by the cutting down of the personnel on grounds of supposed economy.

## Strength of the Personnel.

The officers and warrant officers on the active list of the United States Navy, who numbered only 1,683 in 1900 increased to a maximum of 11,209 in 1919, fell in June, 1920, to 9,199, and before the close of the year to 8,700. They now probably number about 8,000. The "line" officers on July 1, 1920, numbered 5399. In June of that year a new departure was initiated of transferring not more than 1,200 temporary and reserve officers, many of them commissioned from warrant rank, to the permanent establishment after qualifying examination. Before the war, Annapolis furnished practically all the officers, the law permitting only fifteen warrant officers to be promoted yearly. By these new arrangements no serious shortage of officers can arise, though there are some critical features. Qualified "line" or executive officers are difficult to procure. Some temporary and reserve officers have not applied to qualify or have failed, and strong efforts are required to complete the numbers.

Failing legislation, it will be necessary to revoke temporary appointments of 7 rear-admirals, 67 captains, 154 commanders and 380 lieutenant-commanders. The new arrangements apply both to the Staff and the line, and permit the retention of 500 reserve officers on the active lists, to be employed in the auxiliary and aviation services. These dispositions supersede those of the war, and place the officer personnel on a permanent basis. The men of experience who came into the Navy during the war and are continued, may lack the polish of Annapolis, but they know the business of the sea. There is a movement further to democratise the Navy. In 1914, the doors of Annapolis were opened to enlisted men, and special schools for their education were provided. Mr. Daniels' theory was that every scholar should carry the potential stars of an admiral in his ditty box. His successor is not likely to entertain any other idea. But, looking into the future, the promise for officers is not encouraging. There are now some twenty rear-admirals who will still be of that rank in 1930, by which time about 110 captains will have attained the statutory age of 56, and will either be promoted or retired under the age clause. In the regular course of promotion by seniority, a large proportion of these captains will not attain the higher rank; and if the selecting Boards exercise their privilege of going further down the list to make selections, the situation will be even more hopeless for any officer who has been passed over even by one Board. This situation, of course, affects officers of junior ranks.

A new feature of strength in the United States Navy is the creation of a great Reserve, which began to be organised by the Bureau of Navigation in September, 1919. Eight years ago, no Naval Reserve existed, but a small beginning was made, and the Act of 1916 was the basis on which 300,000 reserves were embodied during the war. The total strength is now about 28,000 officers and 235,000 men, of whom about 8,500 officers and 100,000 ratings are fully qualified for duties with the Fleet. These Reservists are divided into categories for the active Navy, for the auxiliary services, and for the aviation branch.

Some reference may now be made to the Marine Corps, which is an integral part of the naval personnel. The Corps greatly distinguished itself during the war, winning the approval of Marshal Pétain by its services at the Blanc Mont Massif, Saint Mihiel, in the Argonne-Meuse offensive, and in the crossing of the Marne in the final engagement of the war. The Corps has now been placed on a permanent basis. The establishment of its active enlisted strength in 1920 was 27,400. As has been noted above, Mr. Denby is prepared for a reduced establishment of 24,000. The establishment does not seem ever to have been reached. In 1920 there were 922 officers, 97 warrant officers, 43 accountants, and 18,000 men, with a total reserve of over 19,000.

## The Distribution and Bases of the Fleet.

It has been stated in many quarters that there was an intention of concentrating the two battle squadrons of the United States Fleet

in the Pacific, but no decision has been arrived at with that object. The views of the House and the Senate have been considered, and congressional opinion, embodying the views of localities, cannot but be weighed by the Navy Department. There is also the traditional policy of maintaining a Fleet in the Atlantic. The Department pointed out to inquirers that no reason, political or strategic, existed for assembling the Fleet in the Pacific. There were, as yet, no adequate resources for supplying and docking so large an aggregation of forces for any length of time. Moreover, it was suggested that such a demonstration might have an unfortunate influence upon the relations of the United States and Japan. The general policy is, therefore, that two fleets shall be maintained in separate existence, with provision for their assembly as a Grand Fleet, which can at any time be effected by the waterway of the Panama Canal, whenever the occasion arises. For the co-ordination of their training, they are to concentrate from time to time, and in pursuance of this scheme, the Atlantic Fleet passed through the Canal early in 1921 and manœuvred with the Pacific Fleet. They cruised along the coasts of Peru and Chile—a significant event, this being the most formidable force that had ever appeared in those waters. The assembly not only put into practice the intended junction of the Fleet, thus demonstrating the strategic use of the Canal, but was said to have enabled the Admirals to work out some problems of war. Recent orders indicate that the Pacific Fleet will be constituted entirely of oil-burning ships and of 14-in.-gun ships, except that the Maryland, first of the 16-in.-gun ships, will join it. It will include the California (flag), New Mexico (second flag), Idaho, Tennessee, Mississippi, Maryland, Arizona, Oklahoma, and Nevada.

The discussion of the right distribution of the Fleet has brought into new prominence the colossal needs of a great Fleet in the Pacific. The latest report of Mr. Daniels stated that there was no more pressing problem than the provision, in those waters, of ample bases and repair facilities. The problem is to develop such resources on the Pacific coast of the States, and to extend all necessary resources, as it were in a chain across the ocean, by Hawaii to Guam and the Philippines, a chain whose strength would obviously depend upon floating strength. Mare Island, being inaccessible to ships of deep draught, may lose its importance. Last year, Congress authorised a Committee to report on the Pacific coast bases. The Committee consisted of five Senators and representatives of the House and Senate naval committees, accompanied by Admiral Coontz, Chief of Operations, Rear-Admiral Charles W. Parks, Chief of the Bureau of Yards and Docks, and some others. Visits were paid to Seattle, Bremerton on Puget Sound (where a previous scheme proposed a first-class base at a cost of £9,000,000, and where there are 12,000,000 gallons of oil), Port Angeles, Wash., Portland, Astoria, Oreg. (where a destroyer and submarine base is planned, for which a preliminary appropriation has been made), San Francisco, Los Angeles, Oakland, Mare Island, Monterey, and other places. Nothing is yet known of the outcome of this report. On San Francisco Bay, the sites of Hunter's Point, Alameda and Carquinez are being discussed. In

1919, a committee of investigation had made recommendations concerning some of the positions. San Diego is being developed into an immense supply base, with vast storehouses, barracks, complete repair and docking facilities, a hospital, and air station, the last now at work, as well as storage for 4,200,000 gallons of oil on Point Loma, and a wireless station. At Hawaii, on Pearl Harbour, a dock 1,000 feet long was completed in 1919, and there is oil storage for 15,000,000 gallons. Work is in progress at Guam, in accordance with the plans of the Navy Department, but comparatively little has been achieved, and Congress has yet to vote adequate supplies. In the Philippines there is very little that is modern. In the final settlement of the Naval Appropriation Act, 1921–22, the Senate lost its project for a submarine and destroyer base at Guam, as well as its proposals for a naval air station at Sand Point, Wash., a submarine base at San Pedro, Calif., and further provision for the submarine base at New London.

Finally, general reference may be made to the great increase of the naval establishments and resources for the Fleet. The year 1920 witnessed the practical completion of the greatest works programme ever undertaken for the American Navy. The older dockyards have reached a high level as industrial establishments. The immense dry docks at Norfolk, Pearl Harbour, South Boston, and Hunter's Point on California Bay, are completed or completing. Aviation resources have been increased, and an aircraft store and hangars have been completed at Hampton Roads. The Lakehurst dirigible hangar is nearing completion; the helium plant at Port Worth, Texas, is now producing the new balloon gas. Submarine bases at New London and Hampton Roads are completed and in operation. In addition to the oil storage mentioned above, Yorktown has 30,000,000 gallons and Guantanamo 15,000,000 gallons.

Reference is made above to the wireless control of the battleship Iowa. The ship has since been subjected to bombing practice, and Mr. Denby has given details of the control system employed.

When everything on board is ready, the main engines are started and left running very slowly. The ship is then abandoned, and controlled from another ship. The wireless direction sent out is taken in by the aerial on the Iowa and transmitted to the receiver located below. It is then amplified by means of vacuum tube amplifiers and made to operate a very sensitive relay or switch which in turn operates a larger relay. This latter closes an electrical circuit which operates a pneumatic valve. When this valve opens, it admits compressed air to the throttle control of the main engines, which opens and brings the ship to full speed. The relay also operates a device called a commutator, which is a special switch controlling the steering mechanism.

The steering gear consists of a standard steam-driven rudder gear, the throttle valve of the engine being geared to a small electric motor. The commutator is connected to the control panel of this motor, and is thus able to operate the electric motor, which in turn causes the steam engine to drive the rudder to either starboard or port as desired. The automatic steering works with the aid of a gyro-compass. The compass is electrically connected to the control panel of the electric motor on the steering gear, so that the ship can be made to hold any course. The gyro-compass immediately operates the steering gear to return the ship to her course.

The commutator might be considered the mechanical brains of the Iowa. It receives the wireless directions and interprets them, passing them on directly to the electric motor controlling the steering engine, if the order is either starboard or port, or giving the gyro-compass control, if that is the order. If the officer in control desires to stop the Iowa he sends a long signal of about ten seconds' duration. This

operates a special relay which opens the circuit of an electrically controlled pneumatic valve, which shuts off the various fuel-oil and feed-water pumps, thus shutting down the power plant and stopping the ship. A special safety device is provided in the form of a time clock, which automatically shuts everything down in case the radio receiving apparatus should become inoperative or in case no control signals were received after a certain lapse of time.

## JAPAN.

Before describing the Japanese shipbuilding programme, which, in association with the expansion of the American Fleet, is a matter of commanding interest in the present international situation, it will be well to say something, as briefly as may be, concerning the administrative system of our Allies, to indicate the distribution of their Fleet, and to give some facts concerning the personnel.

The administrative organisation of the Japanese Navy is divided into two independent sections, a sharp distinction being drawn between the duties of the Staff and those of supply. The system resembles that of the German Navy under the Empire, but the crucial error is avoided of allowing the Navy Department (administration) to dominate the Naval General Staff, and practically almost to reduce it to impotence. The Chief of the Staff is Admiral G. Yamashita. His department is concerned with war plans, and the handling and movements of the Fleet, and comprises the Operations, Mobilisation, and Intelligence Branches. The Navy Department or Administrative Division includes the Bureaus of Military Affairs, of Personnel, of Naval Education, of Law, of Accounts and Supplies, of Munition Work, and of Medical Affairs, with a Secretarial Bureau. In addition to these Bureaus, the three great departments come under the control of the Minister of Marine —of Naval Construction and Material, of Naval Engineering, and of Naval Works.

Japanese official information shows that, in May, three permanent squadrons were maintained in Japanese home waters: the First Squadron (Admiral S. Tochinai) comprising 2 Dreadnought battleships, 3 light cruisers, and a flotilla of 16 destroyers; the Second Squadron (Vice-Admiral K. Suzuki) comprising 2 battle-cruisers, 3 light cruisers, and a flotilla of 16 destroyers; and the Third Squadron (Vice-Admiral K. Oguri) comprising 3 pre-Dreadnoughts, 1 cruiser, and 8 destroyers. In addition, three Cruiser Squadrons were maintained abroad, one in Chinese waters comprising 1 cruiser and 5 river gunboats; one Squadron in Southern waters consisting of 2 cruisers; and the Training Squadron formed of 2 cruisers. The training cruisers are the Yakumo and Idzumo. They are now engaged in circumnavigating the globe for the training of executive and engineering cadets. In the House of Commons on March 16, the Parliamentary Secretary to the Admiralty said that the Japanese had then in full commission 12 battleships and 6 battle-cruisers, as well as one of each class attached severally to the Gunnery and Torpedo Schools.

The Japanese personnel have a great and well-deserved reputation for their qualities of efficiency, courage, and endurance, of which they

have given proof on many occasions. The present total number of officers and men is about 76,000, with some 35,000 reserves. The actual numbers borne on January 19 was officially stated to be 76,000, including about 7,000 officers. The corresponding number in 1914 was 55,712. The Japanese are an island race and have been seafarers for very many centuries. For the ratings of the Fleet, both the volunteer and conscript systems are in use. At the present time, the volunteers amount to 75 per cent., and the conscripts to 25 per cent. The adoption of two systems does not result in a reduction in the number of volunteers, but certain branches, such as stewards and carpenters, are more eligible as conscripts, and the arrangement removes the danger of a shortage of ratings. The period of service for volunteers is six years, and for conscripts three years.

Deck or executive officers are trained at the Naval College, which is entered by open competition, candidates being between the ages of sixteen and nineteen, and the course is of three years. At the Gunnery and Torpedo Schools there is a six months' preliminary course, followed by one year's advanced course. The Navigation Course is of one year, and the War Course of two years. Engineer officers enter at the Engineering College by open competition between the ages of sixteen and nineteen years. They have a Technical Course of six months, an advanced course of two years, and a more advanced course covering one year.

All ratings undergo a course of six months at the Naval Barracks. Seamen are sent to the Gunnery and Torpedo Schools for six months' preliminary course, six months' advanced course, and six months each for the gun-layer's and gyroscopic courses. At the Signal School, the preliminary course occupies about four months and the advanced course six months. At the Wireless School the preliminary course is of one year and the advanced course of six months. The Seamanship School has a course of six months. Stokers, mechanics and electricians spend a year in preliminary and advanced courses. Special arrangements are made for training ships' writers and stewards, sick-bay stewards and carpenters. The system of promotion from the lower deck is by selection from amongst those who have served for the minimum period, and selections are made from among the warrant officers who have graduated in the Technical Course of the Naval College.

## Shipbuilding Policy.

The "eight-eight" shipbuilding programme is progressing in execution, without either acceleration or retardation. It is organic in the sense that dockyards and supplies proceed *pari passu* with it in their development. It lacks nothing in its requirement of highly trained officers and men. As was explained in the last volume of the "Annual," the object is to give Japan sixteen capital ships—eight battleships and eight battle-cruisers—none of which shall at any time exceed eight years in age. For at least twelve years, the Japanese Navy Department has had this programme in view. It has never been admitted—indeed it has been explicitly denied—that the

Navy had any such offensive purpose as is often assigned to it. Mr. Takashi Hara, the Premier, last January described the programme as in reality an old one. "Its function is to defend our coasts and commerce—nothing more." The Naval Authorities had decided that the Fleet was insufficient for this purpose. "Hence we must continue to build." Admiral Baron Tomosaburo Kato, Minister of Marine, had just before declared that there would be no departure from the programme. Shortly afterwards Baron Hayashi in London, and Viscount Ishii in Paris, said the programme should cause no alarm, because Japan would remain definitely inferior to the United States. On New Year's Day, General Baron Tanaka, Minister of War, said: "In the present world situation disarmament or curtailment of armaments is impossible for Japan."

### The Naval Programme and Expenditure.

The general proposition of the Japanese authorities may be summarised in this way: Whatever agreement for the limitation of armaments may yet be entered into, Japan must first be allowed to complete her eight-eight programme, which establishes her policy so far as any one can foresee. This programme is an old scheme of expansion, for defence only, demanded by the necessity of protecting the ocean-borne commerce of Japan and the coasts of the Empire. The completion of the programme will still leave Japan behind the United States—some Japanese leaders say also behind Great Britain—in naval power, even though the United States should complete only the programme of 1916.

There has recently been some opposition in a section of the Japanese Press to the naval policy of the Japanese Government, and in February last Mr. Ozaki, late Minister of Justice, after his expulsion from the Kansei-kai, supported by the Independents, introduced a disarmament resolution, which, however, was rejected by 285 votes to 38. He contended that Japan, being a signatory to the Covenant of the League of Nations, should observe its provisions, and insisted upon the point that Japan spends 32 per cent. of her revenue on Naval armaments, while America expends only 14 per cent. The other points of the opposition of the Independents are that, when national resources are taken into account, the Japanese naval programme is the most ambitious scheme of expansion yet undertaken in time of peace by any nation except Germany. They say that it imposes on the people an effort greater than that of Germany in 1914 when her war preparations reached their maximum, and when, on her pre-war estimates, she was spending only 6·2 per cent. of her income on her Navy. In fighting power it is alleged that the programme aims at placing Japan nearer the United States than Germany was to England in 1914. It will place Japan as almost the equal of America, and will relegate the British Navy to the third place.

Such arguments, it is said, will not weigh heavily with the Japanese, who, though recognising peace as necessary for their welfare, are intensely patriotic, and are accustomed to regard their island

empire as located with relation to the Asiastic mainland, much as the British Islands are to the continent of Europe, as having similar needs, and as being confronted with analogous dangers. That the Japanese bear a great burden may be seen from the figures of their naval estimates. The naval outlay (round figures) in 1916–17 was £15,000,000, in 1917–18 £18,000,000, and in 1918–19 £25,000,000. The shipbuilding programme and consequential expenditure increased the expenditure in 1920–21 to £55,950,000, and the estimates for the new financial year, prepared by the Minister of Finance last December, amount to no less than £74,700,000 (498,000,000 yen), an increase of £18,750,000 (125,000,000 yen *). The total expenditure for national defence—Army and Navy together—is estimated at £114,150,000 (761,000,000 yen) out of a revenue of £236,250,000 (1,575,000,000 yen), being an approach to one half of the total. Owing to revisions and readjustments of the expenditure, which are usual, it is a little difficult to determine the precise amounts actually devoted to the Navy. Baron Kato said, a month before the estimates were presented, that the expenditure would be £22,500,000 (150,000,000 yen) above the normal, but contended that the huge budget did not mean increased naval expansion, but simply increased costs, and whatever other nations might do, Japan would not exceed her eight-eight programme. But Baron Hayashi, speaking in London in June on the meeting of British Empire Premiers, said he was sure the Japanese Government would be willing to come to an arrangement with England, France and America to reduce the burden of armaments.

## Battleships and Battle-Cruisers.

It may now be useful to indicate the steps by which the programme was reached, and to give some details of its character and execution. A temporary programme for building three Dreadnoughts was approved in 1914, but not until two years later did the eight-eight programme take shape—that is, with the approval of the Imperial Diet. A compromise was approved in that year, for eight battleships and four battle-cruisers, to be completed in 1923. Six of the eight battleships were the Fuso, Ise, Yamashiro, Hyuga, Nagato, and Mutsu, of which the Fuso was already completed, the Ise and Yamashiro launched and nearing completion, and the Hyuga building. The Nagato and Mutsu were designed, but were not immediately put in hand. The Kaga and Tosa, to complete the eight battleships, came later. The four battle-cruisers of the programme were the Kongo, Hiyei, Kirishima, and Haruna, all of which had been launched, and the Hiyei and Kongo completed and commissioned.

The next advance was the increase of the eight-four plan to an eight-six programme. This was approved by the Imperial Diet in 1918–19 in the ordinary session, and the extended scheme was not finally sanctioned until the summer of 1920, in an extraordinary session of the Diet. Of the eight battleships in the 1916 programme,

* An Admiralty statement (August 2, 1921) gave the 1920–21 estimates at £48,820,550.

four are included in the 1920 eight-eight programme. These are the Nagato and Mutsu, and the Kaga and Tosa. Three months after the voting of the 1916 programme, came the Battle of Jutland, which threw new light on the problems of naval design, and caused delay in the beginning of the ships. The Nagato was laid down more than a year after the battle, and the Mutsu more than two years later. Both these vessels, therefore, belong to what will be regarded as a new classification—that of post-Jutland ships. The battle-cruisers of the 1916 programme do not form part of its successor, of which the eight battle-cruisers are indicated below.

The following table shows the eight-eight programme in the matter of capital ships, all of which will belong to the post-Jutland category of capital ships. The dates for the later ships are conjectural:—

BATTLESHIPS.

| | Laid down. | Commissioned. | Displacement. |
|---|---|---|---|
| Nagato . . | Aug. 1917 | May 1920 | 33,800 |
| Mutsu . . | June 1918 | June 1921 | 33,800 |
| Kaga . . . | June 1920 | 1923 | 40,600 |
| Tosa . . . | Feb. 1920 | 1922 | 40,600 |
| Owari . . . | 1922 | 1925 | 45,000 |
| Kii . . . | 1923 | 1925 | 45,000 |
| G. . . . | 1925 | 1927 | 45,000 |
| H. . . . | 1924 | 1927 | 45,000 |
| BATTLE-CRUISERS. | | | |
| Amagi . . | Dec. 1920 | 1923 | 40,000 |
| Akagi . . | Dec. 1920 | 1923 | 40,000 |
| Takao . . | 1922 | 1924 | 45,000 |
| Atago . . | 1922 | 1925 | 45,000 |
| E. . . . | 1923 | 1926 | 45,000 |
| F. . . . | 1924 | 1926 | 45,000 |
| G. . . . | 1925 | 1928 | 45,000 |
| H. . . . | 1926 | 1928 | 45,000 |

## LIGHT CRUISERS.

The programme provides for the construction of 20 light cruisers, 8 under the 1916 programme and 12 more under the expanded programme of 1920. The Kuma and Tama, of the Kiso class, were commissioned early in the year. Two others, the Kitakami and the Oh-i, were launched last year and should be completed before the end of 1921. After the Kiso class come 6 others, of which the Nagara, Isudzu, and Natori, are in fairly advanced stages. The Yura and Kinu have been laid down (the latter in January), and these, with the Abukuma, complete the series of six. All will probably be completed in 1923. Others to complete the strength should be ready in 1925 or 1926. Three of them have been named—the Ayasi, Otonase, and Minase—and are building respectively at Sasebo, Nagasaki, and Uraga.

## Destroyers and Submarines.

With regard to destroyers, it is understood that the Japanese programme includes 29 of the first class, in addition to 7 completed and 8 which were in commission at the end of 1920. The destroyers completed, building, and planned will thus give Japan 44 first-class modern vessels in 1923 or 1924, all displacing 1150 tons or more—the most recent increased, as is reported, to 1900 tons—mounting 4·7-in. guns, and having three, four, or six T.T. Of the large number of second-class destroyers completed, 7 were commissioned last year, 47 others are building or projected, promising to give Japan a total of 78 second-class destroyers, to be completed by 1923 or 1924. In addition are about 46 smaller destroyers completed by 1911. It has been stated by the *Jiji Shimpo* that Japan is completing destroyers of the later "Kase" class, probably 1,900 tons and 36 knots, at the rate of five a year, and second-class destroyers at the rate of about ten a year. The expansion of the building facilities which is in progress should provide means of adding to this programme.

Very little is known concerning recent additions to the submarine flotilla. The "Japan Year Book" reported, early in 1919, that the Kure yard would complete Submarine No. 23, being one of three of a larger class (950 tons), in June of that year, and would then undertake seven more of the same type. Recently the construction of submarines was begun at Yokosuka, Sasebo, Maizuru, the Mitsubishi yard and Kawasaki. According to the "Japan Year Book" there will be 80 first class submarines by 1927; there are now about 20.

## Building Resources and the New Ships.

There are at present only four slips in Japanese Imperial and private yards large enough for the construction of battleships and battle-cruisers of post-Jutland dimensions. These are at the Kure dockyard, where the battle-cruiser Akagi is in hand, and where there are factories fully equipped with plant for the production of the heavy armour and 16-in. guns for the Fleet; the dockyard at Yokosuka, where the Amagi was laid down last December; the Mitsubishi private yard at Nagasaki, where the battleship Tosa has been in hand for nearly two years; and the Kawasaki Company's yard at Kobe, where the battleship Kaga is being built. The private establishments last named are expected to secure contracts for the construction of the battle-cruisers Takao and Atago, and to lay their keels after the launching of the Tosa and Kaga in 1922. The State yards at Kure and Yokosuka will begin building the battleships Kii and Owari when the Amagi and Akagi have been put in the water, which is expected to be in 1922 or early in 1923. For the repair and refitting of the gigantic ships which are being built, a dry dock is under construction at Kure, the work having been begun in 1920. The Kure yard has four docks, of which two were large enough for the first Dreadnoughts. Much of the structural steel, as well as armour plating, comes from the State ironworks at Yawata on Kyushu Island.

Light cruisers are built at the Sasebo dockyard on Kyushu Island, near Nagasaki, the private yards of the Mitsubishi and Kawasaki Companies, and the new Uraga private yard, which has six berths for vessels up to 12,000 tons. Last year the Kawasaki Company launched the Oh-i; the Mitsubishi, the Tama; and the Government yard at Sasebo, the Kitakami. The Uraga yard is now building the Isudzu.

Six yards are building destroyers, of which two, the Mitsubishi and the State yard at Maidzuru, near Osaka, apparently confine themselves to the construction of large destroyers of the Suzukase class. The others are constructing second-class destroyers. These are the Kawasaki yard, the Uraga yard, the Fujinagata yard, near Kobe, and the Ishikawajima yard situated on an island near Tokyo. Destroyers have been built recently at the yard of the Osaka Iron Company.

The Kawasaki yard at Kobe and the Mitsubishi works are understood to be constructing about one half of the submarines. Submarines are also being built in the State yards at Kure, Yokosuka, and Sasebo. In addition to the yards named there are others of minor importance, chiefly employed in commercial work, but capable of naval employment, and a large protected harbour is being formed on Tokayama Bay, with repair shops and stores.

## Naval Air Service.

It has been reported by the American Director of Naval Aviation, and is doubtless true, that the Japanese have latterly become very active in naval aviation. They have obtained a good deal of material from Germany and other countries, and have had the assistance, unofficially, of English and French instructors. The American officer said that Japan was organising flying squadrons to co-operate with the naval forces, and was establishing aviation schools and stations on her coasts, as well as embarking 'planes in battleships and employing them in manœuvres. She has laid down one aircraft-carrier, the Hosho, and is proposing to begin another.

The Japanese Air Service is divided into the Military Wing and the Naval Wing, under the Military and Naval Departments, respectively; they are quite independent of each other. There is also an Air Board which serves under the Cabinet, and its principal functions are to control civil aviation. The Naval Wing has a permanent Flying Corps. There are Naval Air Stations at Yokosuka and Sasebo under the Commanders-in-Chief of those naval ports. Certain of the permanent squadrons have an Air Wing attached to each of them, coming under the Commander-in-Chief of the Squadron. In relation to material and research, the Air Section is in the Department of Materials, Tokio (Kansei-Honbu), and there is a Naval Aircraft Experimental Laboratory under the same Department. Most of the naval arsenals at the naval ports have factories for the manufacture of aeroplanes and engines.

One training section is attached to the Yokosuka Station, and the training service is under the direction of the Commander-in-Chief at

Yokosuka, but supervised by the Chief of the Educational Department, Tokio. All personnel forming the Air Wing are drawn from the original Naval Service. Pilots are chiefly drawn from officers of the Naval College and the Naval Engineering College, but the Japanese are also drawing pilots from lower ranks.

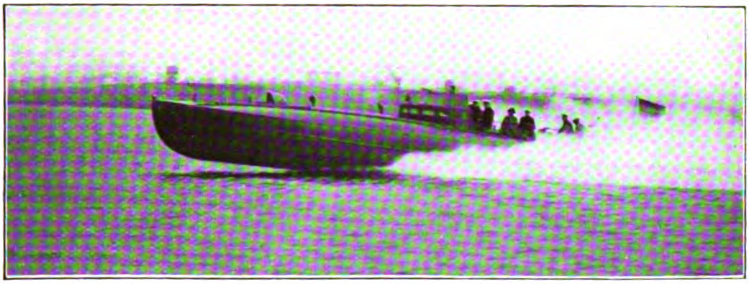
## FRANCE.

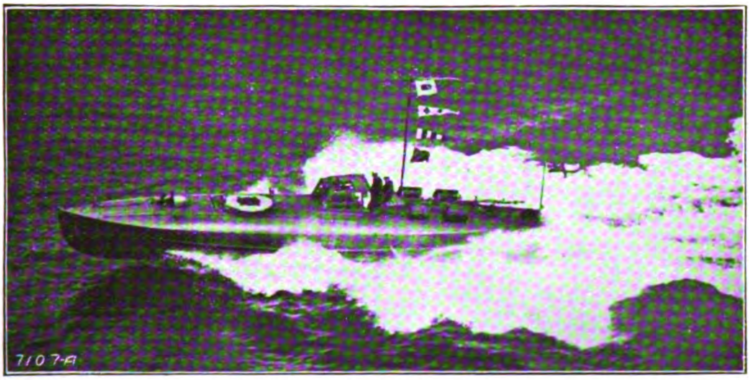
The French Navy, which, after the war, was demobilised even more rapidly than the Army, is still engaged in a most difficult task, no other than that of surveying the old Navy and discovering how, out of its useful elements, a new Navy can be constituted. The means available are very restricted, but the Fleet will yet be placed in a situation to meet all conditions that can be foreseen. It will have the advantage of being provided with its own Flying Service, which was brought into existence in 1914, and will be retained. French naval officers are sanguine of its future. The Senate voted 33,807,300 francs for the purpose during the present year. The Administration has also undertaken to organise the Coast Defences, being a duty that came to the Navy early in the war.

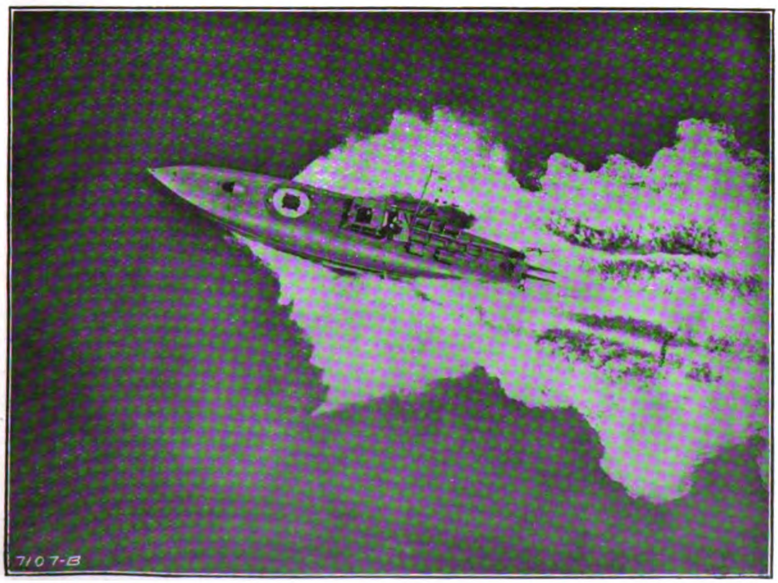
A work of liquidation was first imposed upon the authorities. It was necessary to disengage clear principles from the lessons of the war, and to transform them into rules of practice. A great many of the older ships have been condemned. Many warships were placed on the sale list more rapidly than the yards could break them up. No pre-Dreadnought battleships now remain save the Condorcet and the Diderot. The Démocratie, Justice, Verité and Vergniaud have recently been struck out of the list, together with some of the armoured cruisers. A great many men who had lost their value in the Service have been discharged, and economies have been made in numberless directions. The work of reconstruction will follow, and is being prepared for by a whole series of studies and experiments. The strategical reclassing of the material for the Navy has not yet been completed.

Quite recently a Centre of High Studies has been created, and the Historical section has been constituted afresh. Under the direct orders of the Chief of the General Staff, a Department for Scientific Research and Discovery is at work. The number of ships in commission has been reduced, in order to constitute out of the best units, a smaller squadron, sufficient to maintain a nucleus of highly trained men. Owing to the present international situation, some of the ships are distributed, but as this situation clears, these vessels will be brought home for training work with the Fleet.

In the last volume of the "Annual" (p. 54), some account was given of the system of French Naval Administration in the Staff and the Superior Council of the Navy. The object has been to dissociate the Staff and its important work from the duties of supply and to bring the Staff system nearer to that of the Army. Every Navy is pre-occupied with the same question, and each has approached the problem from its own historic standpoint. No important change has since taken place in the system at the Rue Royale, but the






**THORNYCROFT COASTAL MOTOR BOATS SIMILAR TO THOSE BUILT FOR THE FRENCH NAVY.**

Fitted with two sets of Thornycroft petrol engines, each developing 375 B.H.P. Speed 37 knots.

Armament: (upper figure) 2—18-in. Torpedoes and 2 pairs of Lewis guns.

,, (central and lower figures) 1—18-in. Torpedo and 4 Depth Charges.

authorities are now considering the question of evolving a type of organisation for the naval forces, and in the Arrondissements Maritimes, analogous to that at Naval Headquarters.

## Reduction of Naval Establishments.

For many years past, successive proposals have been made and rejected for the reduction of the number of dockyards, on the ground of their redundancy. Very great local opposition has been offered to such attempts. Last year the plan of bringing together the Arrondissements at Brest and Lorient was again brought forward, but the scheme has been abandoned *jusqu'à nouvel ordre.* The proposals which were made for giving over to private constructors a part of the dockyards of Lorient and Rochefort have been abandoned, and these establishments will therefore remain to the Navy in the same situation as heretofore, though the naval authorities have not hidden their view that no military reason justifies their retention. The reduced demand for naval shipbuilding caused the Government, after the war, to direct attention to the needs of the Mercantile Marine, and in 1920–21, a certain number of merchant ships were constructed in the dockyards. It was thought that there would be the double advantage of doing work which the private yards could not then undertake, and of providing work for men who would otherwise have been unemployed. More recently, however, it has been decided, because of the abundance of tonnage which had since become available, and the high price of construction by the State, to abandon civil construction in the dockyards.

## Provision of Personnel.

With regard to the personnel, it may be said that the Inscription Maritime continues its work as before the war, but cannot alone supply the whole of the complements required for the work of modern ships. In particular, it would leave them deprived of large numbers of men for special duties. The number of voluntary enlistments to supply the need has been reduced since 1918, owing to the higher pay which could be obtained in private engineering establishments, and the ease with which young men have found employment in civil life. There was a veritable exodus of the junior personnel. In order to remedy this deficiency, a law was passed on March 12, 1921, which authorised the Minister of Marine to levy a contingent from the Land Army to make good the numbers required for the Fleet, it being provided that these men could not, without their consent, be employed outside Europe. Under this arrangement, about 6000 men have been incorporated in 1921. Owing to the new conditions of obligatory service, the system of education, training, and distributing the men has undergone great changes. In order to accelerate promotion, a recent decree has decided upon the retirement of a large number of warrant officers (Officiers-mariniers), who have passed their 25th year, but no special measure has yet been taken with regard to the retirement of executive officers.

### Shipbuilding Programme.

The Budget of 1921, was definitely adopted by the Law of April 30. The credits of the Navy amount to the figure of 831,823,112 francs for the ordinary charges, and 119,719,295 francs for the extraordinary expenditure, which chiefly relates to shipbuilding and repairs. The original demand was for 1,349,514,129 francs and 168,786,149 francs for these two charges, respectively. The Chambers declined to vote the sums asked for ships and vessels which had not yet been put in hand, on the ground that it was unnecessary to provide money for this object while the shipbuilding programme was still undecided. The Admiralty (August 2, 1921) stated that the French Estimates in 1913 were £21,292,400, converted at par rate of exchange, and in 1920, £16,619,909 at the average rate of exchange during that period. A further vote of £2,490,742 had been asked for.

This programme gave rise to long-continued discussion, and in a general way it is now admitted that light vessels, destroyers, and submarines are the craft of which France has the most urgent need. It had been quickly decided that the battleships which were on the stocks at the outbreak of the war should be discontinued. In January, 1920, M. Leygues, then Minister of Marine, proposed to build six cruisers and twelve torpedo scouts, to which his successor M. Landry afterwards added twelve submarines. Although the Naval Committee of the Chamber expressed itself in favour of this plan, it has gone little further than the preliminary stage. The scheme has been modified several times, but now it is agreed that, in view of the uncertainty of the future, it is useless to enter upon an ambitious programme, and that the construction should be limited to the vessels which can be put in hand immediately. Thus reduced, the plan includes three cruisers, six destroyers, twelve torpedo-boats and twelve submarines. At the same time the hull of the battleship Béarn is to be converted for use as an aircraft-carrier.

Under the vigorous impulsion of M. Guist'hau, now Minister of Marine, the cruisers are designed to be armoured vessels of 8,000 tons, with a speed of 35 knots, and armed with a new pattern 19·4 cm. (7·5-in.) gun. All the ex-German vessels have now been re-named, including the torpedo craft. The torpedo leader S113 is the Admiral Sénès, named after the officer who went down in the Léon Gambetta, with his flag flying. The destroyers are named after officers who distinguished themselves.

The division in the Indian Ocean is to be re-established, and surveys have been made for a new base on the south-east coast of Madagascar.

## Germany.

Reconstruction of the German Navy is now progressing, both administratively and in the disposition of the staff and command. Practically a new Navy is coming organically into existence, constituted out of the relics of the old Navy, and yet exactly in conformity with the Peace Treaty. The National Assembly decreed

the formation of the future Navy on April 16, 1919, and after many difficulties and a series of changes, the Defence Law (Wehrgesetz) was voted on March 19, 1921. Under the Imperial Government, the Emperor was the fount of authority and centre of command. Theoretically the Army and Navy were under his direct control, and all high officers were severally responsible to him. In the naval sphere, the Admiralstab (or staff organ of strategy, planning, and organisation), the Chief of the Imperial Navy Office (administration and supply), the Commanders-in-Chief and the Inspector-General of the Navy were individually responsible to the Emperor. The theoretical merit of the system was that it separated the functions of planning and command from those of supply, but in practice the Navy Office grew so powerful that it completely dominated the Staff.

Under the system of the Republic—Law of March 23, 1921—a Minister of National Defence, controlling the Reichs-Wehr-Ministrium, was established, and under his direction and authority are the Army (Reichsheer) and the Navy (Reichsmarine). Article 6 of the Law sets forth the strength of the Navy, in accordance with the provisions of the Peace Treaty, at six battleships, six small (light) cruisers, twelve destroyers and twelve torpedo boats. Other articles disannul the old laws of universal service. All officers and men are volunteers. Under Article 8, the President of the Republic is Commander-in-Chief of all the forces, like the President of the United States. He is "Oberster Befehlshaber."

## Administration.

At the head of the Navy is the "Chef der Marine Leitung," or Chief of Naval Direction, Admiral Behncke, whose functions include both those of the Staff and of supply. It was he who, as Deputy-Chief of the Admiralstab, issued the first warning to shipping to avoid the North Sea on account of the submarine campaign. At Jutland he commanded the Third Battle Squadron, and afterwards, in October, 1917, the forces employed against the Baltic Islands. Under his direction are (*a*) the floating forces, (*b*) the coast defences, (*c*) the Inspectorates, and training and research establishments, and (*d*) the technical administrative and other branches. Under the Inspector of Training (Rear-Admiral Dominik) is the officers' school at Flensburg-Mürwik, and under his direction has been placed the branch of Naval Archives, which is engaged upon the naval history of the war, and whose officers are Captain Erich Raeder and Commanders Friedrich Lützow, Otto Gross, Firle, and Otto Schultze. According to the distribution of business (Geschäfts-Verteilung) which was to come into force on February 5, the following is the system, showing the duties of Admiral Behncke's central office, and the functions of the Officers in his department:—

*Chief of Naval Direction* (Marine-Leitung): Distribution of the military personnel; organisation and regulations of the Departments; officials and workmen; naval cabinet; special dispositions concerning the engineering personnel; naval

estimates; position and appointments of officers; medical and sanitary duties.

*Office of Naval Command* (Marinekommando-Amt), Rear-Admiral Püllen: Organisation, education, and training; strategic and tactical questions, and plans concerning the employment of naval and land forces; ships at home and abroad; legal questions; gunnery training and coast-defence questions; general questions concerning the use of under-water weapons, and of coast defence by such means, of mines and bombs, and of signalling, telephones, wireless, cyphers, foreign intelligence, etc.

*General Naval Office* (Allgemeines Marine-Amt), Vice-Admiral Löhlein.—*Dockyard Division:* Organisation; repairing and refitting ships; technical questions; dockyard personnel; administration stores and material; hydrography. *Construction Division:* Building ships and large repairs; study of U-boat construction; building and large repairs of destroyers, etc.; experiments and trials; electro-technical equipments of ships; further examination of electro-technical U-boat questions; steam and other machinery; fuel researches, discoveries, etc. *Armaments Division:* Guns and breech mechanisms; ammunition, powders, explosives, ballistics, and shooting tables; gun-mountings; range-finding apparatus; coast defences; provision of arms, small arms and ammunition; torpedoes and torpedo armaments; development and provision of mines and mine defences. *Nautical Division:* Matters concerning the mercantile marine, school ships, surveying and charts; fishery defences; nautical instruments, ship models, etc. *Sea Transport Division:* General questions relating to the mercantile marine; transport; naval and army transport at sea, and administrative questions relating thereto.

*Naval Administrative Office* (Marine-Verwaltungs-Amt). Director Reuter: Pay, pensions, allowances, travelling etc.

In addition to these principal departments of the Marine-Leitung, are others concerned in the relation of the Navy to the Ministry of National Defence (Reichs-Wehr-Ministerium).

It may be observed with regard to the foregoing statement, that the office of Naval Command undertakes Staff, intelligence and planning duties; it is the "brain." The General Naval Office is concerned with supply, and with research and investigation. Though no large shipbuilding is to be undertaken, and no new submarines are to be built—they are ruled out by the Peace Treaty—everything is to be organised, and every development is to be watched and studied.

### Distribution of Forces.

The ships and vessels left to Germany by the Peace Treaty are being divided between the Baltic and the North Sea. Two Squadrons are to be maintained for the training and employment of officers and men, and the ships in the Baltic are to show the flag to the

separated Germans in East Prussia. The *Marine Rundschau* said, in June, that the centre of naval gravity had shifted from the North Sea to the Baltic. The naval command has been moved from Kiel to Swinemünde, and the fortress of Pillau has been taken over by the Navy. For the Baltic command, Commodore Freiherr von Gagern was selected, to fly his broad pennant in the Hannover, with the Hessen and Schleswig-Holstein under his orders, and the small cruisers Medusa, Thetis, and Berlin, and a flotilla of six destroyers and six torpedo boats. The squadron is not yet complete, the only battleship being the Hannover. Kiel has been reduced to a captain's appointment. There are wireless stations at Neumünster, Bülk, Swinemünde, and Pillau. Coast-defence sections are at Kiel (also for the garrison of Sylt), Swinemünde, and Pillau.

For the North Sea Command, Rear-Admiral Zenker has been selected, and his squadron will be constituted exactly like that in the Baltic, but the organisation is not so far advanced. The Braunschweig is to be flagship, with the Elsass and Schlesien, and the small cruisers Hamburg, Arcona, and Amazone; the Braunschweig was to be commissioned later in the year. Wireless stations are at Borkum, Nordholz and List. Coast-defence sections are at Emden (for Borkum and Norderney), Wilhelmshaven (for Schillig and Wangerooge), Geestemünde (for the Lower Weser), and Cuxhaven (for the Lower Elbe).

## PERSONNEL.

The institutions of the old Navy are generally in use for training purposes. Executive and engineer officers and paymasters will be educated and undergo courses at the fine establishment built at Mürwik, and warrant officers at Wik, near Kiel. Nucleus crews for training are at Stralsund and Wilhelmshaven. The men are all long-service volunteers. The revolution began on the lower deck, but now all disaffected men have been ejected, and those newly joined are reported to show excellent spirit. There have been great difficulties, but social disorder has been overcome. The new men, attracted by good pay and the prospect of promotion to commissioned rank, were formed into military organisations and served in Silesia and elsewhere. Last year they returned to the ports to constitute coast defence divisions and form the nucleus crews for the ships coming forward for commission. It is probable that the new men will be trained as infantry for a year. The provision of crews has been one of the impediments to the process of reorganisation.

Pay appears to be on a reasonable scale. There is a basic rate for volunteers and for each commissioned rank, to which is added a variable supplement, but the scheme shows a local rate ("Ortszuschlag"), and to the sum of these two 50 per cent. is added to compensate for increased cost of living. The gross sums reached, shown in marks, are as follow: volunteer, 8,400; sub-lieutenant, 10,500; lieutenant, 12,300; lieutenant after five years, 13,800; senior lieutenant, 15,750; lieutenant-commander, 18,300; lieutenant-commander after three years, 19,000; commander (Korvetten-Kapitän),

24,150; frigate captain, 27,300; captain, 33,000; rear-admiral, 43,500. Although promotion is uncertain, it is officially believed that the cadet will become a lieutenant in four years and will get his next step eight years later. He will be promoted to Korvetten-Kapitän after a further six or seven years, and eight or nine years later will become a captain. The captain is expected to spend five years in that rank before becoming a flag officer. A sum of 140,000,000 marks (£7,000,000 at pre-war rates) is included in the "permanent" estimates of 1921–22 for pay.

### Dockyards and Establishments.

The reduction of the German Navy to a small establishment has had a profound effect upon the dockyards. The former Imperial Yard at Kiel has been taken over by a limited industrial company, and only a small area remains to the Navy under the designation of "arsenal." The naval gunnery school is at the port, as also are the inspectorate of training, controlling of the naval schools, the pay and clothing offices, and the naval hospital; on the Bay at Friedrichsort is the mining experimental station and depot. The torpedo-experimental station is at Eckernförde. Wilhelmshaven is now the only German dockyard, but a large part of the establishment is employed in building cargo and fishery craft. There will be built the light cruiser of the Dresden class which is to replace one of the older cruisers whose prescribed age limit has been passed. Upon a displacement of 5600 tons she is to embody the lessons of the war, with an armament of eight 6-in. guns, three 22-prs., and four torpedo tubes. The heaviest gun in the cruisers left to Germany by the Treaty is the 4·1-in. Preliminary outlay (approximately £100,000 at current rates) has been provided for. No other shipbuilding is as yet projected. At Wilhelmshaven the nucleus crews are trained, and at the same port are a naval hospital with sick-bay staffs for embarkation, and some technical and store establishments.

## Italy.

The position of Italy in the naval world is still one of great difficulty. Her outlook is uncertain and her financial means are restricted. Austria-Hungary, her great naval rival and long potential enemy in the Adriatic, has disappeared; but new nations are rising, and elements of danger are visible to Italian eyes in the future. She possesses in the Mediterranean—much more since the conquest of Libia and the extension of her territory in Istria and to the borders of Fiume—a longer coastline than any other Power. Her geographical situation opens her to the menace of any aggressive State. Her interests are on the sea and beyond the sea. Equilibrium in the Mediterranean is therefore her constant thought, the scope of the action of her Ministers and a fundamental care of her Government.

At the conclusion of the war, the great necessity for reducing expenditure made instant demands upon the Navy. Reference was

made to this matter in the last issue of the "Brassey's Naval and Shipping Annual." The great ships which were in hand were stopped, and large numbers of older vessels condemned. A searching inquiry was made into the position. The problem was to cut away everything that could be dispensed with, and yet to leave the naval defences unimpaired. The lessons of the war, the suggested reduced value of capital ships, and the vastly increased importance of the flotillas, seemed to indicate the way.

Personal changes went forward *pari passu* with material changes. The naval commands were soon affected, for the floating strength was reduced and navigation was restricted. On February 21 the command of the naval forces in the Adriatic was suppressed. By Royal decree of February 17, the naval command at Venice was to be abolished, and in its place a command was instituted at Pola on April 16, analogous to the commands at Spezia and Taranto, with the same departments and services. A Rear-Admiral remains, with local authority, at Venice. The naval command at Ancona was suppressed on April 21, as also was that at Brindisi, except that the coast defence command continues at the latter port. For local defence, Ancona is brought under the Army, and for matters relating especially to naval defence, under Venice. By the same decree, the limits were defined on the coasts of the four chief commands of Spezia, Naples, Taranto, and Pola, of the lesser coast-defence commands, of the naval services at Messina, and of the local naval command in the Lower Adriatic and at Brindisi. Everything tended to the right maintenance of necessary defences, with outlay reduced as much as possible. The necessity for immediate effort in construction was reduced by the inclusion in the fleet of three former German and two former Austrian light cruisers. These are the Taranto (ex-Strassburg), Bari (ex-Pillau), Cesare Rossarol (ex-B97, perhaps better classed as a large flotilla leader), Brindisi (ex-Helgoland), and Venezia (ex-Saida).

The estimates for the Navy for the financial year 1921–22 (July 1 to June 30), as presented by the Minister of the Treasury to the Chamber of Deputies, amounted to a total of 847,837,767 lire (equivalent to about £34,000,000 at pre-war rates, and £10,869,715 at current rates), including 311,000,000 lire called for by charges due to the liquidation of war. The sum accounted as normal was thus 536,837,767 lire (£21,750,000 pre-war). On what are known as effective estimates, there was a reduction of 385,090,650 lire. New construction, which absorbed 179,964,360 lire in 1916–17, required no more than 85,482,500 lire in 1919–20, and now demands only a round figure of 50,000,000 lire (£2,000,000 pre-war), of which 15,000,000 lire are to be expended in the dockyards, and 35,000,000 lire in private establishments. The naval air service absorbs 1,000,000 lire for the personnel, 5,000,000 lire for maintaining efficient and renewing the material of flight, and 1,000,000 lire for plant, hangars, etc., in all £280,000 at pre-war rates.

The shipbuilding programme is modest and includes no large units. The vessels already in hand are 3 scouts of the Leone class; 6 destroyers of about 800 tons (La Masa class); 8 of about 900 tons

(Palestro and Curtatone classes); 6 gunboats, 200 tons; 1 gunboat (E. Carlotto), 200 tons; and some auxiliary and local vessels. The new programme comprises 8 mine-layers of about 800 tons; 1 oil transport of 7,000 tons; 4 submarines of about 600 tons submerged displacement; 1 or 2 scouts of about 5,000 tons; 4 destroyers of about 900 tons; and 8 torpedo "M.A.S." (motoscafi anti-sommergibili), being motor anti-submarine chasers discharging small torpedoes. These latter will evidently be more effective vessels than many of the light motor-chasers which were built and bought in large numbers during the war. The mine-layers, the oil transports, and the submarines are to be constructed in the Royal establishments, as also are four vessels for railway services, adapted to be used as auxiliary cruisers, and some vessels for other Government departments, and for use in the Straits of Messina. The scouts, destroyers, and the "M.A.S." will be given out to private yards.

The vessels to be laid down are in conformity with the ideas put forward in 1920–21, and with the means available, as well as with the restrictions made advisable by a feeling of uncertainty concerning the future of naval construction. It is, moreover, provided that the characteristics of the vessels shall be submitted to the Council of Admirals, which is a most authoritative advisory body attached to the Ministry, including the most experienced technical officers, and that the programme shall then be presented to the competent Parliamentary Committees before being put into execution. It is thought a happy arrangement that the Chamber shall take part in the decision, without publishing details over which it may be desirable to maintain a certain reserve.

On grounds of economy and practical advantage, the Minister, with the advice of the Council of Admirals, has been authorised to sell, or otherwise dispose of, battleships of the second and third classes, scouts and torpedo craft dating from 1903 and earlier, auxiliaries of 1905 or earlier, and minor vessels of any class. In some cases, vessels of local use may be lent to private companies. A return made by the British Admiralty and presented to Parliament early in the year, showed that the right of sale extended to 3 Italian pre-Dreadnoughts, being the Napoli, Regina, and Roma, 6 destroyers, and 14 submarines.

The battleship Leonardo da Vinci, sister of the Conte di Cavour and Giulio Cesare, was brought, by extraordinary exertions, and as a triumph of Italian naval engineering skill, from the place where she lay at Taranto, and some work is proceeding upon her. It has always been a point of national and professional pride with the Italian Royal Corps of Naval Engineers to salve every ship of the Navy which could be brought to safety. They triumphed in the case of the San Giorgio. The Leonardo da Vinci sank keel uppermost as the result of an explosion on August 2, 1916. She was a danger where she lay, and steps were taken to refloat her. Divers excavated a space around the ship, holes in her were filled with concrete, and a trench was dug about a mile long through which she was drawn to a dock. She was there patched up, and towed out to open water, where, by flooding certain compartments, she was enabled

to right herself by natural means. The operation was completed on January 24, since which time some work of cleansing and repairing has been conducted upon her hull and fittings; but no decision has yet been arrived at as to what shall be done with her. A considerable sum would be required to make her serviceable, yet no specific charges on her account are included in the estimates of 1921–22.

Some improvements have been effected in the position of the personnel, whose strength is maintained, as in the previous year, at 40,000 men, and owing to increased costs and supplements to pay, the expenditure is higher, without, however, departing from the severe restrictions in the naval estimates as a whole. The naval institutions and schools are maintained. Owing to a social, national, and political upheaval, the personnel of the Italian Navy has passed through a crisis, the worst effects of which, however, seem now to have disappeared.

## Spain.

The Spanish naval programme is now progressing with some activity. The light cruiser Reina Victoria Eugenia, 5,590 tons, 25 knots, which was long on the stocks at the yard of the Spanish Naval Construction Company at Ferrol, is now approaching completion. The same concern has laid down two other light cruisers of lesser displacement, 4,820 tons, with six instead of nine 6-in. guns, but with the higher designed speed of 29 knots. At Cartagena, torpedo boat No. 21 has been completed, and No. 22 is in hand, as well as six submarines of 610–740 tons displacement (of which the first was launched on June 2), with three destroyers of 1,140 tons and 34 knots, and three coastal gunboats.

## Sweden.

The coast-defence ship Drottning Victoria, 7,605 tons, underwent her trials on March 31. In two runs on the measured mile, her speed was 24 knots, exceeding the contract by 1½ knots. Her Westinghouse turbines have been supplied by the Lindholmen Mekanisk Verkstad of Gothenburg.

The commission of naval officers appointed to consider the future naval policy of Sweden has presented an interim report. No big ships will at present be built, but the Minister of Marine has presented estimates for 15,000,000 crowns (£825,037 at pre-war rates and £882,353 at current rates) to be expended in the years 1922–24 on the construction of submarines.

## Norway

There is nothing to report relating to the Norwegian Navy. A scrapping of everything that does not correspond with the lessons of the war has been in progress and is being continued. The period of service of conscripts has been reduced. No action seems to have

been taken on the report of the mixed committee on the future of the naval and military forces, so far as the former are concerned.

### Denmark.

The small, but efficient, Navy of Denmark is not developing except in the completion and exercises of the small craft. The ex-British sloop Asphodel has been embodied in the Fleet under the name of Fylla, and is to be used for fishery protection in Iceland waters. Admirable work has been done by the Danish Navy in the destruction of mines in the Belts and in the seas on the coasts of Denmark. It was officially reported that in the year 1920, 907 mines had been removed or destroyed, making a total of 9,754 since the beginning of the war, of which 7,300 were English, 2,141 German, and the remainder not recognisable. The Danish authorities reported that of these mines, 78 per cent. of the German mines were still efficient, but only 4 per cent. of the British, in relation to which matter, the remark may be permitted that, in so far as these British mines had broken adrift, they conformed closely to the view of the British Navy, adopted at the Hague Conference of 1907, that mines must become innocuous as soon as they have broken their moorings; and that, in so far as they were anchored mines, they were of the defective type described by Lord Jellicoe, which did not begin to be replaced by a better type until towards the close of 1917.

### Belgium.

It was announced early in the year that the Belgian Government contemplated the acquisition of four small warships to be constructed in French establishments, these to constitute the nucleus of the Belgian home forces, which now consist of a sloop, and three small ex-German torpedo-boats and two submarines.

### The Netherlands.

The Navy estimates introduced in September, 1920, provided for an expenditure of £4,347,299, being £355,047 more than in the previous year, and including £1,112,600 for new construction. Further provision is made for continuing the two protected cruisers for the Dutch East Indies, of which the first, the Sumatra, was launched on December 30 at Amsterdam in the presence of Queen Wilhelmina. The sister ship Java is being built by the Scheldt Company at Flushing. The vessels will displace 7,050 tons, and have a speed of 30 knots, obtained from triple screws driven by oil-fired boilers and turbines. They will have armoured decks and 3-in. side armour; and an armament of ten 6-in. guns and four 3-in. anti-aircraft guns, with six searchlights and equipment for using aeroplanes. The complement will number 480 officers and men.

In February, the mine-layer Hydra, 680 tons, was sunk in collision with the torpedo-boat Z3, 182 tons, during exercises without lights in the Wielingen Channel; no lives were lost. The torpedo-boat suffered little damage and the Hydra has since been floated.

In the Queen's Speech at the opening of Parliament on September 20, 1921, a Bill was announced for the strengthening of the Navy in view of the defence of the Dutch East Indies.

## JUGO-SLAVIA.

According to the *Rivista Marittima* (June), when the French evacuated Cattaro, they handed over to Jugo-Slavia the fortifications of the place, together with the old ex-Austrian ironclads Erzherzog Rudolf and Erzherzog Max, as well as a dozen old torpedo-boats which were lying at the port. At the distribution of the ex-enemy forces, 12 torpedo craft were assigned to Jugo-Slavia. The Bocche di Cattaro were very heavily fortified during the possession of the place by Austria-Hungary, and there were coaling and oiling resources and some ship-repairing plant at places on the inclosed waters. The French have also presented a small naval motor boat, the Vedette, to Jugo-Slavia.

In the estimates of the new State for 1921–22 a sum of 200,000,000 dinari (equivalent to about £8,000,000 at Belgrade before the war, and now to about £1,500,000) was allotted to the naval forces, being a considerable increase. A competition was opened for entries of the personnel, as follows: 100 at the non-commissioned officers' school, 150 at the school for wireless telegraphy, 45 at the engineering school, 25 as electricians, and 100 as gunners, torpedomen, etc. A beginning is thus being made with the organisation of a trained force for sea service.

On the Danube Jugo-Slavia controls the former Austrian armoured monitor Bodrog, built in 1904. Three former Hungarian gunboats on the river, which the Jugo-Slavs had claimed, were recently handed over at Orsova, to Roumania.

## GREECE.

The period of service of Captain Howard Kelly and his staff at Athens having expired, the Greek Government have secured the services, as naval adviser, of Rear-Admiral Aubrey Smith.

## ROUMANIA.

The Roumanian Fleet on the Danube and in the Black Sea is likely to develop rapidly, and has recently received the accession of certain vessels, not of recent classes, ceded by other Powers. These include the Italian scouts Nibbio and Sparviero, the French gunboats Chiffonne, Friponne, Mignonne and Impatiente, seven former enemy torpedo-boats, and three former Hungarian gunboats on the Danube transferred from Jugo-Slavia. The Roumanians have recently established a naval base at Sulina on the Black Sea at the mouth of the river.

## RUSSIA.

The Russian Fleet is completely disorganised, and only a few units are in a seaworthy condition. No detailed statement can be

given of the condition either in the Baltic or the Black Sea. When Colonel Koslovsky, who led the Kronstadt revolutionaries, arrived at Helsingfors, he said that the ammunition supplies having given out, the guns of the fortress were destroyed and the battleships Petropavlovsk and Sevastopol blown up. The Poltava went aground in the Neva, and the Gangut was laid up, being in a bad state of repair. Certain vessels of the flotillas and small craft fell into the hands of Finland and Esthonia, but some cruisers, destroyers, and submarines remain in the hands of the Soviet Government, and the submarines have shown signs of activity in the Eastern Baltic.

The Black Sea Fleet, as a Russian force, has ceased to exist. The ships which constituted Wrangel's squadron arrived at Bizerta, and were placed under French protection. They comprised the Dreadnought battleship General Alexeieff (formerly the Alexander III.), a pre-Dreadnought battleship, two cruisers, ten destroyers and four submarines. The most vital elements in the Black Sea forces of the Soviet Government are the torpedo and submarine flotillas, if the personnel can use them. The names of Korfu, Lesbos and Zante are new to the destroyer lists. No statement can be made of the destroyers now in the Black Sea. There are six or more modern submarines. At least one submarine has been launched by the Soviet authorities, and the threatening attitude of the Black Sea submarines became the subject of correspondence between the British and Soviet Governments in November, 1920.

In the British White Paper [164], July 26, it was stated that Russia possessed, of ships not more than 20 years old from the date of launch, 14 battleships (including the Demokratiya building), and 4 battle-cruisers (all building). The battle-cruisers are the Borodino, Ismail, Kinburn, and Navarin. In addition the return gives 9 cruisers, 9 light cruisers building, 119 destroyers (21 building), 7 torpedo-boats, 58 submarines (22 building), and 13 gunboats. Comparatively few of the vessels given as completed in this list possess any value.

## Chile.

The arrival in Chilean waters last December of the Dreadnought Almirante Latorre, formerly the British battleship Canada, accompanied by three big destroyers or flotilla leaders, caused a certain stir in the South American States, where it was said the balance of power was being disturbed. The Chilean Foreign Minister has therefore explained the features of the naval programme, which are not well known. He said that the acquisitions represented only the repurchase of vessels taken over for the British Navy during the war. The Chilean naval programme was adopted as long ago as 1910, and was put into effect by the Laws of July 6, 1910, and October 21, 1911. It comprised two Dreadnoughts, six destroyers, and certain submarines. Of these, all that the Chilean Government received were the destroyers Lynch and Condell, and they have now re-acquired one Dreadnought and three more destroyers. To complete

the programme of 1910, therefore, one Dreadnought and one destroyer are still required. According to paragraph 3 of the Law of 1910, a sum of £400,000 was to be set aside every year to provide for the construction of a first-class warship embodying the most recent improvements, but up to the present this sum has not been expended. There has been some talk of Chile acquiring the former British battle-cruisers Indomitable and Inflexible.

The strength of the personnel was established last year at 689 officers and 6,058 men, the recruits for the Navy not to exceed 1000.

## Brazil.

There is a certain agitation in Brazil and other South American States caused by post-war developments and future uncertainties. When the Brazilian Congress opened in May, the President said he would ask for appropriations for the purchase of light cruisers, destroyers, submarines, and aeroplanes. The Brazilian Press recently stated that the Government of that country was in treaty for the acquisition of the ex-British battleship Agincourt. She was originally built at Elswick for Brazil, but before completion was taken over by Turkey and given the name of Sultan Osman I. At the beginning of the war she was requisitioned for the British Navy under the name of Agincourt. She mounts fourteen 12-in. and twenty 6-in. guns. It is intended to proceed with the arsenal on the Ilha das Cobras at Rio.

## Argentina.

Nothing has yet been done to give effect to the plans for acquiring swift scouts, destroyers, submarines, and mine-layers, or to increase greatly the general resources of the Navy.

## Peru.

Three submarines were ordered last year from the Ansaldo-San Giorgio Company at Spezia.

## Lesser Baltic Powers.*

The Baltic States, newly freed from the domination of the Great Powers, are endeavouring strenuously to assert their position among the States of Europe, and, among other things, to organise from small beginnings their naval and military forces.

Poland.—The programme contemplates the creation of a squadron comprising 4 cruisers or sloops, and 16 torpedo-boats, of which latter 6 come from ex-enemy fleets, to be employed only for police purposes. Danzig is being developed, and it is said the Polish Admiralty will be transferred to that port. This, however, is doubtful, and a line of shipping which it is intended to run thence

* Details will be found among "Ships of the Lesser Navies," in the Naval Appendix.

to South America will fly the flag of the Independent State of Danzig. The British Naval Mission, which was to advise on dock organisation, maritime traffic, mine-sweeping, and the like, was withdrawn in January. Two sloops of 500 tons, carrying a small armament, have been built in Finland. The first of these, named Marshal Pilsudski, arrived at Danzig in December. Her complement is about 50 officers and men. Three of the ex-German torpedo-boats were taken over at Leith in September.

FINLAND.—The Finnish Navy has been constituted mainly out of vessels coming from the Russian Baltic Fleet. There are 5 old destroyers, a few torpedo-boats, 5 gunboats, 2 mine-layers, and 5 mine-sweepers.

ESTHONIA.—The small navy of Esthonia is not yet organised. It consists mainly of ex-Russian vessels—2 modern destroyers, 2 gunboats, 2 mine-layers, and a transport.

LATVIA.—No progress has been made in forming the intended naval defence force under the Ministry of National Defence. The coast-line of 340 miles, with the ports of Riga, Libau and Windau, requires the protection of an efficient force, and proposals are under consideration with that object. The Government has conceded the creation of a free port at Libau.

JOHN LEYLAND.

## CHAPTER III.

### THE RISE AND FALL OF NAVAL EXPENDITURE.

IT is very instructive to study the rise and fall of naval expenditure over a long series of years, and particularly appropriate at this period in view of the attitude towards naval armaments of the Great Maritime Powers. They are all concerned with the problems which the Great War forced into prominence. In varying degree, they are dependent upon oversea supplies of raw material as well as of food in most cases, but none of them to as great an extent as the United Kingdom, which has to obtain from oversea considerably more than half the supplies for a population of forty-seven million people. They are all, also, the possessors of mercantile marines requiring protection in time of war, but none of them owns so great a volume of tonnage as the British people. They are all, to a great or less extent, warned to make adequate protection against invasion from overseas.

So far as Europe is concerned, there has been an almost complete suspension of naval shipbuilding for a period ranging from seven years in the case of France and Italy to three years on the part of the United Kingdom, with consequential reductions in expenditure. Germany, Austria-Hungary, and Russia have ceased to have any importance as Sea Powers. The result of the war and the influence it exerted is that the British Fleet is now the only one of the first class remaining in European waters, and there is no indication of any intention either in France or Italy to embark upon the construction of large naval vessels. Modest proposals are being carried into effect in both countries, but they are concerned only with light craft. So far as the British people are concerned, the number of capital ships having been reduced from 82 on the eve of the war to 30—including the battle-cruisers Australia and New Zealand—it is now proposed to build four new vessels in place of the last eight to be discarded. The British Fleet's responsibilities are not confined to European waters, for it still remains the main defence of a world-wide empire with a population of four hundred and forty million people, all of whom are more or less dependent upon sea communications.

It becomes important in the existing circumstances to recall the rise and fall of naval expenditure upon the three great Fleets of the world. In the table on the next page the expenditure on the British Navy is shown over a long series of years. The expenditure is the net sum after making allowance for appropriations in aid—that is, sums accruing from the expenditure of former years which are applied to the reduction of votes in later years, such as the sale of old ships. The British Estimates, unlike those of the United States, make provision for the Coastguard and Marines, as well as for pensions of

officers and men; the votes for "personnel" include cadets and boys under training.

BRITISH NAVAL EXPENDITURE FROM 1892-93 TO 1921-22.

| | Total expenditure. | Pay. | New construction. |
|---|---|---|---|
| | £ | £ | £ |
| 1892-93 | 14,325,949 | 3,495,726 | 4,286,908 ‖ |
| 1893-94 | 14,306,547 | 3,603,038 | 3,224,425 ‖ |
| 1894-95 | 17,642,424 | 3,832,158 | 4,768,761 ‖ |
| 1895-96 | 19,637,238 | 4,059,019 | 6,222,432 |
| 1896-97 | 22,271,902 | 4,381,134 | 7,709,855 |
| 1897-98 | 20,848,863 | 4,608,547 | 5,404,113 |
| 1898-99 | 23,880,875 | 4,938,000 | 7,092,498 |
| 1899-00 | 25,731,220 | 5,208,061 | 7,903,312 |
| 1900-01 | 29,998,529 | 5,507,086 | 9,357,577 |
| 1901-02 | 30,981,315 | 5,805,498 | 9,281,332 |
| 1902-03 | 31,003,977 | 6,075,015 | 8,982,790 |
| 1903-04 | 35,709,477 | 6,356,710 | 11,539,497 |
| 1904-05 | 36,859,681 | 6,785,785 | 11,689,956 |
| 1905-06 | 33,151,841 | 6,835,909 | 10,141,257 |
| 1906-07 | 31,472,087 | 7,064,837 | 9,245,097 |
| 1907-08 | 31,251,156 | 7,025,029 | 8,160,252 |
| 1908-09 | 32,181,309 | 7,158,415 | 7,743,272 |
| 1909-10 | 35,734,015 | 7,241,953 | 9,954,434 |
| 1910-11 | 40,419,336 | 7,358,118 | 13,492,755 |
| 1911-12 | 42,414,257 | 7,486,817 | 12,940,886 |
| 1912-13 | 44,933,169 | 7,720,886 | 13,877,255 |
| 1913-14* | 48,732,621 | 8,262,203 | 14,459,188 |
| 1914-15* | 103,301,862 | 13,637,330 | 30,236,874 |
| 1915-16* | 205,733,597 | 24,321,519 | 59,457,956 |
| 1916-17* | 209,877,218 | 29,399,358 | 44,021,190 |
| 1917-18* | 227,388,891 | 37,559,536 | 51,344,774 |
| 1918-19* | 334,091,227 | 46,373,511 | 60,729,744 |
| 1919-20* | 154,084,044 | 32,385,306 | 25,647,781 ‡ |
| 1920-21 | 90,872,300 | 21,164,000 | 4,036,772 ‡ |
| 1921-22 | 82,479,000 † | 18,314,000 | 3,543,147 § |

Turning to the United States, we are able to give complete figures covering also the whole period 1892–1922. The table opposite shows in the first column the gross appropriations made for the United States Navy, and in the other columns the sums allotted respectively to the pay of the Navy (excluding the Marine Corps), and the "Increase of the Navy," the latter figure including construction, machinery, armour, and ordnance. The other principal figures in the expenditure (not given here) are for the Bureaus of Navigation (in the main, personnel), Ordnance, Equipment, Yards and Docks, Medical, Supply and Accounts, Construction and Repair, and Steam Engineering. Apart from the cost of the 1916 programme and the war expenditure, the most striking feature of these figures is the great and steady increase in the cost of the personnel. In the early

* The increase of expenditure for these years was due to the Great War.

† Owing to the depreciation of currency this sum is, according to a statement made by the First Lord of the Admiralty, equivalent to only £34,500,000 on the basis of the 1914-15 Estimates.

‡ Approximate expenditure.

§ Estimated expenditure.

‖ Exclusive of expenditure under the Imperial Defence Acts, met out of the Consolidated Fund.

years the sums are converted at the rate of $5 to the £1, but in and from 1897–98 onward at $4·8665 to £1.

UNITED STATES NAVAL EXPENDITURE FROM 1892–93 TO 1921–22.

| | Gross appropriations. | Pay. | Increase of the Navy. |
|---|---|---|---|
| | £ | £ | £ |
| 1892–93 | 4,708,653 | 1,460,000 | 1,892,000 |
| 1893–94 | 4,362,292 | 1,460,000 | 1,465,000 |
| 1894–95 | 5,073,365 | 1,496,000 | 2,022,345 |
| 1895–96 | 5,866,802 | 1,529,866 | 2,665,504 |
| 1896–97 | 6,112,532 | 1,620,174 | 2,305,811 |
| 1897–98 | 7,009,202 | 1,692,114 | 2,862,957 |
| 1898–99 * | 23,328,777 | 3,689,604 | 4,361,712 |
| 1899–00 | 10,110,953 | 2,774,102 | 2,135,497 |
| 1900–01 | 13,385,572 | 2,632,466 | 4,344,128 |
| 1901–02 | 16,012,438 | 3,123,453 | 5,219,235 |
| 1902–03 | 16,203,913 | 3,316,181 | 4,701,126 |
| 1903–04 | 16,824,570 | 3,638,363 | 5,327,367 |
| 1904–05 | 19,564,632 | 3,970,840 | 6,549,989 |
| 1905–06 | 22,594,612 | 4,109,730 | 10,141,957 |
| 1906–07 | 20,891,325 | 4,165,135 | 6,777,086 |
| 1907–08 | 20,774,260 | 4,315,216 | 4,924,261 |
| 1908–09 | 25,205,478 | 6,354,785 | 6,227,875 |
| 1909–10 | 28,138,334 | 6,740,674 | 7,976,698 |
| 1910–11 | 27,001,866 | 6,917,812 | 6,939,355 |
| 1911–12 | 25,989,581 | 7,206,212 | 5,843,783 |
| 1912–13 | 25,305,953 | 7,661,618 | 4,226,723 |
| 1913–14 | 28,919,456 | 8,068,356 | 7,258,949 |
| 1914–15 | 30,369,880 | 8,221,663 | 8,505,402 |
| 1915–16 | 32,426,399 | 8,474,378 | 9,422,336 |
| 1916–17 | 65,424,845 | 10,320,952 | 29,866,498 |
| 1917–18 † | 363,933,700 | 34,607,645 | 215,126,337 |
| 1918–19 † | 452,372,840 | 66,350,515 | 67,257,166 |
| 1919–20 ‡ | 130,768,292 | 33,741,599 | 30,412,003 |
| 1920–21 § | 101,476,701 | 27,371,262 | 21,370,597 |
| 1921–22 ‖ | 84,352,204 | 28,768,108 | 18,493,784 |

There are difficulties in arriving at the precise and accurate estimate of the naval outlay of Japan, owing in part to the paucity of

JAPANESE NAVAL EXPENDITURE FROM 1906–07 TO 1920–21.

| Year. | Gross sum. | Year. | Gross sum. |
|---|---|---|---|
| | £ | | £ |
| 1906–07 | 6,000,000 | 1914–15 | 10,279,038 |
| 1907–08 | 8,248,221 | 1915–16 | 12,600,000 |
| 1908–09 | 8,094,886 | 1916–17 | 14,600,000 |
| 1909–10 | 7,490,000 | 1917–18 | 17,000,000 |
| 1910–11 | 7,695,647 | 1918–19 | 25,000,000 |
| 1911–12 | 8,861,829 | 1919–20 | 55,950,000 |
| 1912–13 | 9,533,997 | 1920–21 | 74,700,000 |
| 1913–14 | 9,910,435 | | |

* Year of the war with Spain.

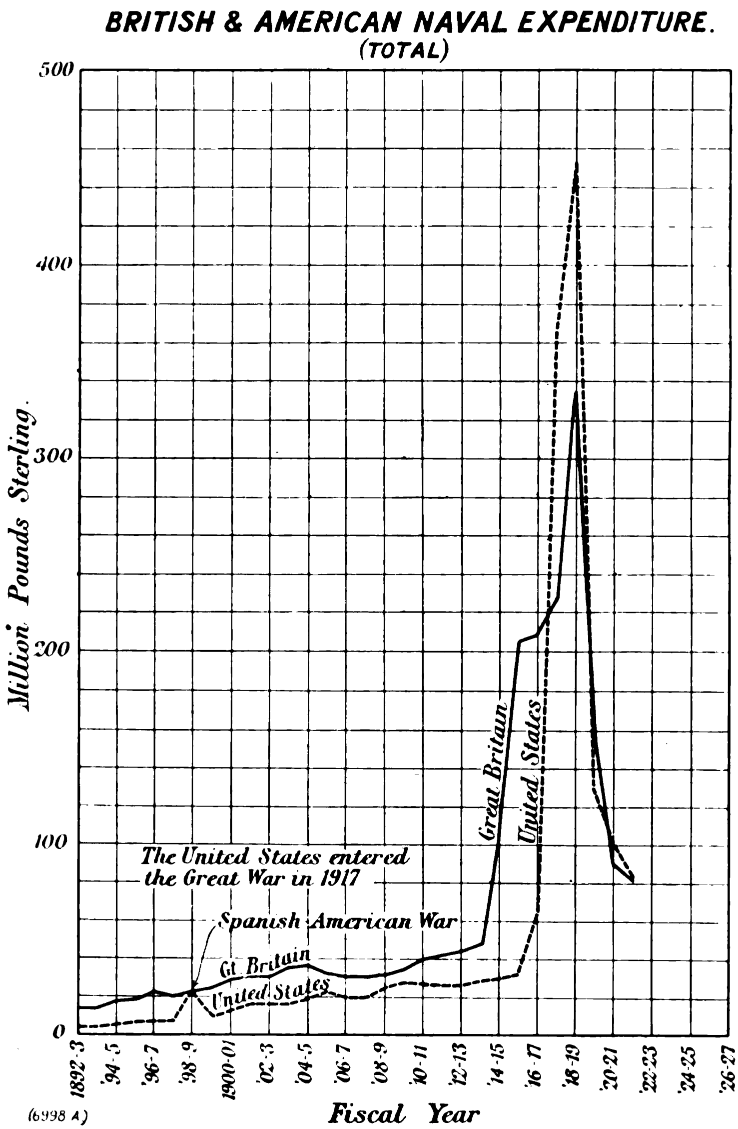
† Years of U.S.A. intervention in the Great War.

‡ Excluding Supplementary Appropriations.

§ Including one Supplementary Appropriation. A written reply to a question in the Commons, August, 1921, stated that the gross appropriations for 1920–21 amounted to £134,468,717, indicating that a further vote might be added.

‖ At the rate of exchange current at the beginning of August, 1921, the estimated expenditure was £112,000,000 instead of £84,352,201.

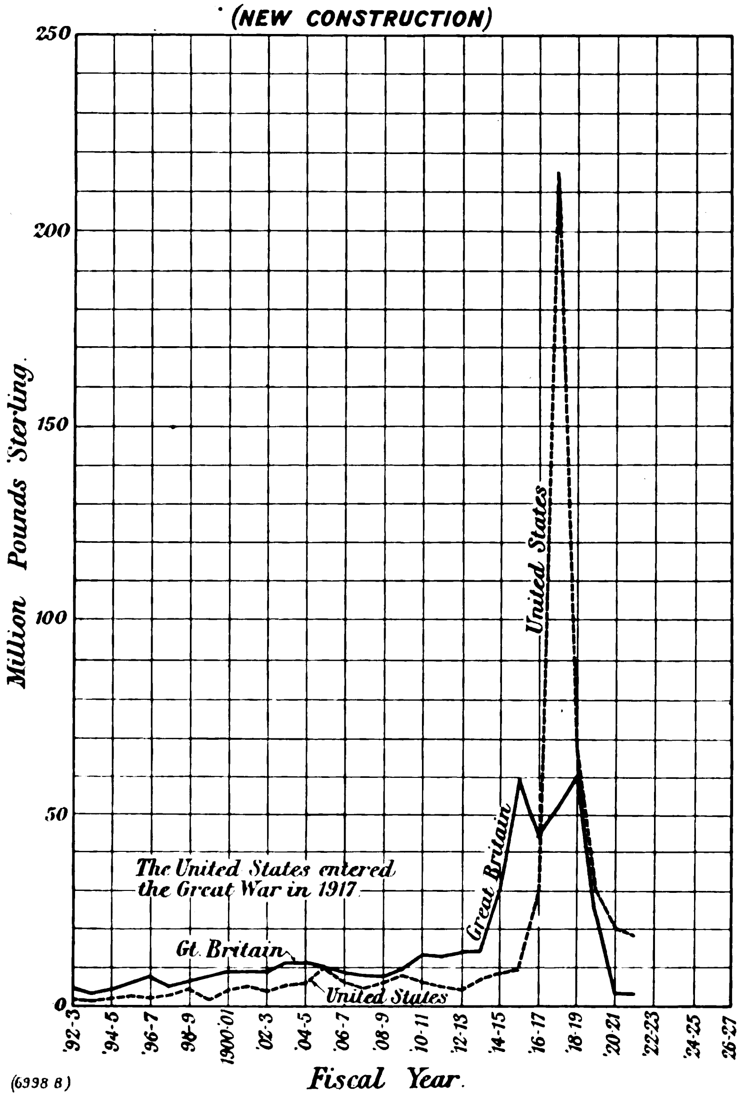
available information, in part to uncertainty as to the objects to which money is actually devoted—as in the case of new construction, repairs and replacements embodied in the armament replenishing fund—and in part to changes frequently introduced into the estimates.




Japanese naval expenditure did not exceed £3,000,000 in 1902–3. There were, however, considerable additions during the war with Russia 1904–5, the prosecution of hostilities by sea having, it has been stated, cost £19,102,175. A great naval expansion which has since been in progress began after the close of hostilities, and has

continued in succeeding years. While details of the expenditure on pay and allowances as well as on new construction are incomplete, we are able to give, in the table on page 71, carefully prepared figures for most years—in some cases estimates—of the gross sum spent upon the Japanese Navy since 1906.

**BRITISH & AMERICAN NAVAL EXPENDITURE.**
**(NEW CONSTRUCTION)**




With regard to the figures last given, Baron Kato, Minister of Marine, stated in December, 1920, that the expenditure was 150,000,000 yen (£22,500,000) above the normal, the rise being due solely to increased costs.

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## CHAPTER IV.

### Comparative Naval Strength.

So far as the European navies are concerned little change has occurred in their composition during the last twelve months. No capital ship was then building, and consequently there are no additions to be made to the lists of the various countries. The general tendency has been in the direction of striking off the effective fleets ships of the older classes, which are no longer regarded as war-worthy. This process of elimination has been applied to all classes of ships, and nowhere more rigorously than in this country. Previous Boards of Admiralty carried out a thorough-going stocktaking in the years immediately succeeding the Armistice, and, in view of the cost of maintaining obsolescent vessels in reserve to the detriment of the active squadrons, the lists have again been revised, as the table which we publish on page 76 indicates.

Although three years have elapsed since the Armistice was signed, there is still no capital ship in European waters, built or building, embodying the lessons of the Battle of Jutland. The Hood cannot be regarded as of post-Jutland design. The plans of this ship were prepared before the British and German Fleets met in the North Sea on May 31, 1916. Work had so far advanced by that date that it was impossible to do more than slightly vary the characteristics of the ship. Moreover, it was not until several months after that action that the Admiralty were in a position to form a considered judgment of the influence it had exerted on the design of capital ships. The result was that when the war came to an end, the Hood was regarded as falling so far short of the post-war standard that it was decided to abandon the three sister ships, for the building of which arrangements had been made. This decision was also influenced by the demand for naval economy. It happens, therefore, that the British Fleet has only one capital unit which reflects even imperfectly the lessons of the Battle of Jutland, while no other European Navy possesses an armoured ship laid down since the opening of the Great War. The significance of that arrest of construction rests upon the long interval of seven years since the opening of the war, and gains increased importance from the knowledge that the lessons of the Battle of Jutland left hardly any detail in the construction of the capital ship, including its armament and armour, unaffected. It follows, therefore, that, so far as capital ships are concerned, all the navies in European waters are now obsolescent, the Hood representing the intermediate stage between the pre-Jutland and post-Jutland man-of-war. So far as light cruisers, destroyers, and submarines are concerned, this is not so much the case, since the construction of these vessels went on after Jutland, and a large number of the later units in the respective classes may be considered as effective for war purposes as any that are now being built abroad.

In contrast with the naval holiday which has been tacitly observed by the naval Powers of Europe, great activity is still being displayed in the United States and in Japan. During the

later stage of the Great War, when the United States was herself involved in the struggle, little progress was made with the battleships, battle-cruisers, and light cruisers included in the programme sanctioned by Congress in 1916, but, on the other hand, during the years 1917 and 1918, not only were the destroyers and submarines included in the programme pushed forward, but additional craft of these types were laid down, and have since been completed Immediately after the conclusion of the armistice in Europe, work on the larger vessels—battleships, battle cruisers, and light cruisers—was energetically resumed. As the result of this activity, the United States Navy will possess within the next two or three years sixteen post-Jutland capital ships. These vessels were laid down after the American naval authorities had consulted with the Board of Admiralty as to the lessons to be deduced from the Battle of Jutland, and the general course of events at sea during the Great War. This resulted in the designs of the battleships being considerably modified, and the plans of the six battle cruisers were entirely recast after the Secretary of the United States Navy Department and his advisers had visited this country. One post-Jutland battleship, the Maryland, was ready for trials at the end of August, 1921, and two others are afloat, the Colorado, launched on March 22, 1921, and the Washington, launched on September 1, 1921.

Japan also has in hand a naval programme, though it is of far more modest dimensions than that of the United States.

The table on page 76 gives a conspectus of the strength of the five leading navies, excluding battleships and battle-cruisers over 20 years old from the date of launch.

In addition to these five leading navies, some reference should be made to the fleets of Germany and Russia. Germany, according to the Admiralty White Paper 164, Session 1921, possesses three battleships of the Deutschland type of 13,040 tons, and five of the Braunschweig type, or a total of eight vessels, being two in excess of the number specified in Section II., Article 181, of the Peace Treaty. Germany has no battle-cruisers, but still retains eight light cruisers, or two more than were specified in the Peace Treaty. She also retains twenty-eight destroyers instead of twelve, and sixteen torpedo-boats, whereas she was allowed only twelve. All her submarines are reported as having been surrendered or broken up. With regard to the ships numerically in excess of the provisions of the Treaty, it should be noted that they are retained by arrangement, and are disarmed, being mostly used for training and barrack purposes. The Russian Fleet is said to consist of fourteen battleships, but their value is negligible.

During the period when the United States and Japan are pushing forward their programmes, many heavy ships which are now in reserve in Europe will have become obsolete, not only owing to their being unable to withstand punishment from the powerful vessels of more recent construction, but also, in part, to their smaller cruising radius. In these circumstances the Board of Admiralty decided in the spring of 1921 to remove eight of the older battleships from the effective list, and to lay down in their place

EFFECTIVE FIGHTING SHIPS, BUILT AND BUILDING.

| Class. | Great Britain.* | | | U.S A. | | | France. | | | Italy. | | | Japan. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Built. | Building. | Total. | Built. | Building. | Total. | Built. | Building. | Total. | Built. | Building. | Total. | Built. | Building. | Total. |
| Battleships with 14-in. guns and upwards | 14[1] | — | 14 | 14[2] | 7 | 21[2] | — | — | — | — | — | — | 5 | 3 | 8 |
| Battle-cruisers with 14-in. guns and upwards | 4[3] | — | 4 | — | 6 | 6 | — | — | — | — | — | — | 4 | 2 | 6 |
| Battleships with smaller guns | 8[4] | — | 8 | 26 | — | 26 | 11 | — | 11 | 8 | — | 8 | 7 | — | 7 |
| Battle-cruisers with smaller guns | 4 | — | 4 | — | — | — | — | — | — | — | — | — | 3 | — | 3 |
| Cruisers | 3 | — | 3 | 15 | — | 15 | 10 | — | 10 | 3 | — | 3 | 3 | — | 3 |
| Light cruisers | 51 | 10 | 61 | 15 | 10 | 25 | 5 | 6[5] | 11 | 10 | — | 10 | 9 | 8 | 17 |
| Armoured Coast Defence Vessels and Monitors | 3[6] | — | 3 | 6 | — | 6 | — | — | — | 2 | — | 2 | 1 | — | 1 |
| Aircraft-carriers | 4 | 2 | 6 | 1 | 1 | 2 | 1 | 1 | 2 | — | — | — | — | 1[7] | 1 |
| Flotilla Leaders | 15 | 2 | 17 | — | — | — | 1 | 12 | 13 | 8 | 3 | 11 | — | — | — |
| Destroyers | 185 | 6 | 191 | 278[8] | 40 | 318 | 70 | 13[9] | 83 | 52 | 12 | 64 | 84 | 10 | 94 |
| Torpedo-boats | 2 | — | 2 | — | — | — | 58 | — | 58 | 86 | 1 | 87 | 19 | — | 19 |
| Submarines | 89 | 8 | 97 | 103 | 46 | 149 | 48 | 17 | 65 | 65 | 3 | 68 | 23 | 15 | 38 |
| Sloops | 29 | — | 29 | — | — | — | 8 | — | 8 | — | — | — | — | — | — |
| Gunboats and Despatch vessels | 3 | — | 3 | 8 | 1 | 9 | 64 | 10 | 74 | 4 | 6 | 10 | 5 | — | 5 |
| River gunboats | 26 | — | 26 | 5 | — | 5 | 2 | 3 | 5 | 3 | 1 | 4 | 3 | — | 3 |

* Including the Dominions.

[1] Including 4 vessels (Iron Dukes) with heavy 13·5-in. guns, comparable to the 14-in. guns of foreign navies.

[2] Including the Tennessee, California and Maryland, now in commission, and the Colorada and Washington, completing afloat.

[3] Including the Tiger with heavy 13·5-in. guns.

[4] Seven other older battleships were removed from the effective list in the financial year 1921–2.

[5] These six light cruisers are projected.

[6] Two other monitors were removed from the effective list in the financial year 1921–2.

[7] This aircraft-carrier is projected.

[8] Fifty-two of these destroyers may be regarded as obsolete.

[9] Twelve of these destroyers are projected.

four new vessels. On August 3 this decision, which had been reviewed by the Cabinet in the light of President Harding's invitation to the Conference at Washington, was confirmed by the House of Commons by a large majority.

In view of the policy of the Government to maintain the British Fleet at a strength not inferior to that of any other Power, any other decision would have represented a denial of the policy adopted, as the First Lord has revealed, with some reluctance by the Board of Admiralty. When the Board agreed to abandon the Two-Power Standard and to adopt the One-Power Standard, it apparently assumed that it would have the consistent support of the Government, Parliament, and the nation in maintaining that modest measure of naval strength which, in the matter of efficient capital ships, is not being carried out.

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# CHAPTER V.

## The Battle of Jutland—A Brief Tactical Analysis.

By a Japanese Naval Officer.

THE criticisms of naval writers on the Battle of the Sea of Japan were quite in agreement in their general features; it was too decisive a knock-out to give rise to any conflicting views on the main issue. Yet as regards details we saw differences of opinion, and, moreover, we find to-day several comments, plausible at the time, now distinctly insupportable in the light of facts which have been since made clear.

Though already a great number of books and articles have appeared on the Battle of Jutland, as yet many important details are not revealed to the public, and the event is still too recent to give a definite unprejudiced judgment on the merits and demerits of the opposing fleets in this great sea fight, unprecedented in its magnitude in the annals of naval history. Such an ambitious scheme is quite outside my intention, and still more beyond my capacity at present. The views expressed in the following analysis are of a nature liable to modification, or even to alteration, when a more accurate and more detailed account is placed at my disposal.

### The Aim of the German Fleet.

The object in view of the High Sea Fleet in putting to sea on that memorable day is clearly stated in Admiral Scheer's book. The Germans were looking forward to an opportunity of bringing to action and destroying a part of the British force. Of the achievement of such a feat, by the way, there was some possibility on the occasion of the bombardment of Scarborough and Hartlepool, December 15, 1914, had they acted more wisely and energetically. (The encounter with the entire Grand Fleet was out of the German programme.) But, after repeated operations of the kind, such good luck was not to be expected and Admiral Scheer leapt unawares into the extended arms of Admiral Jellicoe. The battle, from the German side, was a counter-stroke to retrieve this strategical mischance; a mere desperate struggle to save its own skin. Here one cannot help questioning if Scheer had fully appreciated the very delicate nature of the operation he was about to embark upon. Had he taken sufficient care to keep his plan in strict secrecy? Aerial reconnaissance was impossible and many of the submarines were already on the return voyage. Was there such pressing need for hurrying the project as to justify his dispensing with the full co-operation of these important

auxiliaries? And was he not giving way too much to sentiment in taking the slow and obsolete Squadron II.; useless in chase and a drag in retreat?

### The British Traditional Mission.

Admiral Jellicoe is rather reticent on the cause of the Grand Fleet units proceeding from various bases to the rendezvous at sea on the preceding night. Although the purpose is lightly put down to have been one of the periodical sweeps of the North Sea, it seems quite certain that something was known about the enemy's intended move. Be it a mere sweep or an anticipation of the German operation, I can find no other mission to assign to the Grand Fleet in the heart of the North Sea than that traditional one of the British Navy: the destruction of the enemy Fleet. In short, one feels plainly entitled to conclude that the strategical object of the High Sea Fleet was a limited offensive, while that of the Grand Fleet was an unlimited one. The latter had a much bigger job on hand than the former, and it is quite natural that, in the criticism of the battle, one should be more exacting on the British Fleet than on the German.

In reference to the initial disposition of the British force, the distance that separated Jellicoe from his advanced force under Beatty at two o'clock in the afternoon of July 30, has called forth many severe comments. But I think those critics have missed the real mark, which ought to be sought in another quarter. Was Admiral Jellicoe right in the choice of the rendezvous, its position, and its rather advanced hour, in consideration of the strategical features of the theatre of operation and of the almost clear-as-day intention of the German Fleet to deny a general engagement? I am not going to dwell upon the strategical consideration at length. Only let me put another question on this subject—the attitude taken by the Admiralty towards the Harwich Force. Perhaps they feared German attack in the Channel quarter or the break through of German raiders, although the former theory is untenable in view of the general disposition taken by the Grand Fleet. As to the latter theory, even though some raiders had escaped, entailing some loss of shipping, would it not have been quite a negligible evil if one could have assembled enough force in the main theatre to ensure a decisive victory? The last battalion sometimes decides between victory and defeat; one may therefore enquire what is the good of keeping that force in port.

Admiral Beatty's attempt to cut off the Germans from their base on receipt of the report that the enemy's ships were in sight, and the subsequent chase he gave to Admiral Hipper was proper in principle as well as in execution. The disastrous calamity that befell two of his battle cruisers was entirely due to constructional weakness, and not to any fault of his. Something seems to have been desired as regards concentration. At the moment the Battle Cruiser Fleet came into action, one hour and a quarter after the Galatea's first report, the Fifth Battle Squadron found itself still five miles away.

Naturally Hipper tried to draw Beatty on to the High Sea Fleet and, in a measure, succeeded. But, on account of the fact that the Second Light Cruiser Squadron was reconnoitring ahead of Beatty and that the ships under him possessed a decided superiority in speed over those of the High Sea Fleet, there was little prospect of bringing the British Battle Cruiser Force into a tight hole.

### Admiral Scheer's Change of Plan.

Admiral Scheer says that, on receipt of the report from Admiral Hipper, he shaped the course of the main force first N.W. and then W. in order to place the enemy between two fires, but that shortly afterwards, being informed of the arrival of a unit of enemy battleships, he gave up the intention and hurried northward. Even allowing that his original plan had been carried out, and that he could have attacked Admiral Beatty from eastward and southward, it is very doubtful if he could have overwhelmed him. To achieve the end in view, it was not sufficient to have placed the British between two fires; it was equally necessary to have held them there hard and fast, so that the slow German battleships could close and develop' their full offensive power. This was the business of the scouting group under Admiral Hipper. The attack of the British destroyers, gallantly led by Commander Bingham, was most opportune, and Hipper turned away and relaxed his hold on Beatty. The Scouting Division II., consisting of the six light cruisers under Rear-Admiral Bödicker, which should have occupied a station to threaten Beatty turning north, had yielded this post far to eastward under the fire of the Fifth Battle Squadron. There was also Commodore Goodenough who gave timely information, almost unmolested, of the approach of the High Sea Fleet. Thus at the climax of the entrapping tactics, when the German Battle Squadrons appeared on the scene, there was none to fix and immobilise Beatty. He enjoyed complete freedom of movement and countermarched without suffering at all. German tactics at this stage came to nought after all. The result is not surprising, being the common experience on the games board.

Meanwhile, it might be said that the battlefield was drawn a little to southward, to the interest, if any, of the High Sea Fleet, but, at the same time, it cannot be denied that it led to the disclosure of the presence of the Germain main force and gave Admiral Jellicoe early information to act upon.

### Risks to be Taken.

While Admiral Beatty's chase of Hipper's Reconnaissance Group had been a proper course of action on account of the British superiority in aim and speed, Admiral Scheer's headlong chase, which now ensued to the northward, was of a different nature. He had the pre-Dreadnought battleships with him, so that, if he once got into touch with the Grand Fleet, he would have to accept a general engagement or else sacrifice the Second Squadron. Of course battles

are not run without risks, nor should one let a fair opportunity before one's eyes escape in consideration of a possible danger. The Second Squadron will naturally fall astern in the chase and the fast divisions, drawing ahead, will consequently cover it from a sudden encounter. I do not say that the chase on the part of the High Sea Fleet was tactically wrong or too hazardous; I only point out the difference in the nature of these two tactical moves which should not be passed over.

### Admiral Jellicoe's Task.

The weather thickened as the Grand Fleet drew near the scene. So long as the opposing forces are intent upon a decision, the low visibility affects both sides equally; it does not particularly favour one while imposing on the other a great disadvantage. But the bitter disappointments experienced during the Russo-Japanese War taught us that the influence of weather conditions affects differently two adversaries with opposing aims, especially when there exists disparity in the number or the composition of the forces. For instance, fog or darkness affects the value of numbers and lessens the advantage of numerical superiority, which fact, together with due regard for unseen dangers, will impose on the stronger side a measure of caution, while the weaker may try to avail itself of this temporary unbalancing, otherwise impossible to realise. In addition to the above, the fact that thick weather is a factor which cuts both ways should not be lost sight of. Some critics have cynically commented that Admiral Jellicoe ought to have thanked the fog, without which there would have been no encounter with the High Sea Fleet that day. But the hard fate of an Admiral who has, in a fog and in the vicinity of the enemy, to lead a fleet upon which the destiny of an Empire depends is an uneviable one. The heavy responsibilities and agonising concerns which weigh upon his mind are far beyond the imagination of an outsider. Sitting in the security of a comfortable study and deliberating on the battle charts with no restriction of time, one may easily draw up a better plan than that which Admiral Jellicoe acted upon. But, such a plan, though interesting as an academic investigation, is worthless as a standard to test the merits of an actual decision hastily taken on the battlefield surrounded by the atmosphere of danger and uncertainty. Rather than criticise the veterans in this heartless way, I would gladly accept the censure that my analysis is incomplete.

I have grave doubt whether the formation of the Grand Fleet was a suitable one in such weather as prevailed on May 31. The advantage of divisions in line ahead presupposes good reconnaissance and rapid receipt of reports regarding enemy movements. As the visibility decreased and there was no prospect of getting timely information, would not Admiral Jellicoe have done better to change the formation into a more flexible one and deployed his light forces earlier? Such measures would have done away with the greater part of the confusion and materially eased the task of the British Commander-in-Chief before and during deployment. There was

much to be desired on the part of the subordinate Commanders too, who should have supplied their chief with sufficient information. At Tsushima we see Admiral Togo fully posted up, several hours in advance of the actual meeting, with the disposition, course, and speed of the enemy, who were many miles away: here at Jutland we see Admiral Jellicoe only a few minutes before deployment still uncertain whether the enemy battle-cruisers are ahead or astern of the main body. Jellicoe cannot put the blame entirely on others; he had many fast units under his personal command which he could have turned to good account. All the same, the above-mentioned fact does not reflect much credit on the British Battle-Cruiser Force, which had been more than one hour in contact with the High Sea Fleet. One may even go further and say that at this phase, from the turning north of the Battle-Cruiser Fleet until its junction with the main force, there was no other mission for it than to supply information. Insufficiency of information, if not negligence, was not peculiar to the British; it was the same story with the Germans. The Commanders of both sides, whatever their rank, cannot acquit themselves of this charge merely under cover of low visibility. The cause of the evil lay much deeper: in the defective system, in the doctrine which did not pay due regard to the importance of matters affecting tactics—reconnaissance and information, the means of securing the freedom of one's movements. Upon the question of the deployment of the Grand Fleet, many discussions have been raised and learned theories advanced. It will suffice to say that it lacked the element of surprise—*matériel* dominated *morale*.

## MISTAKES OF THE GERMANS.

Let us turn to the High Sea Fleet. Taken aback by the sudden appearance of the Third Battle Cruiser Squadron and the Second Cruiser Squadron, the German van fell back precipitately on its main body without ascertaining who the new comers were. This hurried retreat was the cause of two evils: it enabled Beatty to round the head of the German line and opened a route for the Grand Fleet to get to the eastward of the enemy; and it led Admiral Scheer to form a wholly mistaken estimate of the situation from which he could never free himself thenceforth.

Ignorant of what was in store, Admiral Scheer strikes forth on a north-easterly course to save the Wiesbaden. But soon he is more than convinced of what awaits him by the hot treatment he receives. The situation is now exceedingly critical for the Germans; it appears to Admiral Scheer more critical than it really is, for he has mistaken the identity of the Third Battle Cruiser Squadron, and considers that the enemy has already encircled him from the eastward. The "ships right about," soon afterwards carried out on a curved line, may be a splendid feat as a peace-time evolution, but, as a battle manœuvre, it is very inopportune and only helps the enemy to complete the encirclement.

During the retreat, a second thought comes to Admiral Scheer and he launches another attack. But his van is shattered, the

destroyers are scattered, and the direction of attack is such that the High Sea Fleet is literally "T"ed by the Grand Fleet. The attack is foredoomed to failure. Scheer executes for the third time "ships right about" just as a handful of his destroyers are speeding on to the enemy. He succeeds in getting free, thanks to the low visibility and to a little excess of caution on the part of Admiral Jellicoe. There was something to admire in the virile decision, the energetic move, and the skill in manœuvring ships, but the commanding will wavered at the last moment and the thrust was not pushed home. The true offensive comes from will, the will to conquer, which does not give in so readily as impulse. Admiral Scheer did things by halves. One might lament his impulsiveness while feeling somewhat impatient at the deliberateness of Admiral Jellicoe. If Admiral Scheer, instead of breaking off too hurriedly at the first attack, had not lost his head, and had surveyed the situation better, he could have carried out an organised retreat, animating the morale of his force by repeated counter-attacks, and inflicting material damage on the enemy while availing himself of the advantage of such a retreat; but I might be tresspassing into the domain of "ifs" and impossibilities. Von Scheer was not very well placed to review the general situation, nor was the visibility good. He had mistaken the Third Battle Cruiser Squadron for the Grand Fleet proper, and there might have been no other thought than that of merely breaking loose. Unskilful choice in the time and direction of the attack and retreat was the natural sequence.

## The Doctrine of Victory.

We all know to-day that the Grand Fleet was favoured with an incomparable situation at this juncture. Though the North Sea mist concealed the fact from Admiral Jellicoe, he knew, at least, that he was in the vicinity of the High Sea Fleet, which a Nelson would have called his. Had the mist cleared a little, or, more possible to hope, had Admiral Jellicoe lifted the veil by pushing on towards "his fleet," one can hardly doubt that there would have been another Trafalgar. Of one thing I am quite certain: there was no lack of that spirit that permeated the sailors of the Royal Navy of the Nelsonian era. We bow low in deep homage to the memory of the gallant Admirals Hood and Arbuthnot who laid their squadrons "alongside the enemy" in its modernised interpretation. The system of command in the Grand Fleet, Admiral Jellicoe's estimate of the effectiveness of the German torpedo, the degree of skill in manœuvring ships and squadrons to avoid enemy torpedoes, etc., in short, the conception of the art of war indoctrinated in the British Navy and the actuality of possibilities and impossibilities are unknown factors to me. There might have been another factor that weighed in Admiral Jellicoe's decision, that of policy. I am treating the matter simply from the military point of view, but let me only add that in war the victory, the annihilation of the enemy, counts for everything.

The nocturnal attack of the British destroyers on the retreating

Germans was carried out with the utmost courage and audacity, which added one more glorious page to the history of the Royal Navy. But the movement of the Grand Fleet as a whole during that night and on the morrow, was rather disappointing. I cannot find any orders given with the object of bringing the Germans again to action at dawn, nor am I well informed of other dispositions and measures taken to that effect. That the Battle Fleet placidly kept on the original course leaving the Battle-Cruiser Force widely separated even after the destroyer attack revealed the approximate movement of the High Sea Fleet; that the Sixth Battle Division fell far astern with the damaged Marlborough; that no light forces were ordered to search for and keep in touch with the enemy; that the destroyers were scattered and the Battle Fleet merely retraced the old route on the morrow—these are the facts that I can gather from Admiral Jellicoe's book, and which I find very difficult to explain by the theory of the renewal of the action. Of course, any elaborate plan we can work out to-day at leisure was beyond execution on account of the uncertainty of the enemy movement, the consideration for the danger of German mines and submarines, the inadvisability of any complicated combination in the dark where one might easily mistake friend for foe, and so on. Still it seems inadmissible to let the chance slip away on the pretext of the dispersed condition of one's own forces. To determine the time and place of meeting the enemy, regulate the movement of the various units and concentrate for battle, such, we are told, is the art of command. If the blockade was deemed sufficient and the destruction of the enemy not necessary, or too costly, it will be necessary to alter all our ideas.

### The Failure of the Torpedo Tactics.

Many writers expressed disappointment at the results of the Japanese torpedoes during the Russo-Japanese War, especially those of August 10. The destroyer action at Jutland abounds with brave and gallant deeds on both sides, and yet the results are disappointing. To speak outright, the British had no flotilla tactics, had totally neglected the importance of the concentration of force and effort. Their destroyers attacked in small batches, many of them attacking single-handed and launching their torpedoes one at a time. Their night action, however admirable in bravery and quite respectable in the results obtained, cannot be held in very high estimation from the point of view of the art of war. It was not an organised offensive. It was rather that the Germans suffered themselves to be attacked and not that the British sought their destruction. On the German side, more than one hundred torpedoes were expended during the day action, and a single hit was scored on the Marlborough. The cause is obvious. The greater part of these torpedoes were fired at extreme range and the reputed German mass attack was more in name than in reality. Torpedoes are slow weapons after all. One has to close in under cover of friendly fire or else one has to launch torpedoes in great numbers while the enemy is deprived of the freedom of movement; that is the co-operation of arms, the part to be played by the

capital ships in a day torpedo attack. Twice the High Sea Fleet turned its back on the enemy as the destroyer attack was developing. Some attribute immense moral effect to these attacks, referring to the breaking loose of the High Sea Fleet. But breaking loose is not a battle, and the torpedoes are entitled to claim a more positive *rôle* in a day engagement. As to the failure of the German flotillas during the night, the blame should be laid principally at the door of the Commander-in-Chief, who was wholly occupied with running away and neglected to keep touch with the enemy, which is the primary requisite for a successful night attack.

### Neither Victor nor Vanquished.

There was neither a victor nor a vanquished at Jutland, both sides failing to achieve the end in view. Admiral Jellicoe preserved the Grand Fleet from the danger of the German torpedoes, while Admiral Scheer can boast of having saved the High Sea Fleet from the clutch of the superior enemy. But these cannot be true aims in battle. There is only one epilogue in the Book of Battle—destruction of the enemy, and no other.

The Germans showed attainments in skill and ingenuity, the fruits of long years of training and laborious investigation : smoke screen, good shooting, "ships right about" on a curved line, destroyer mass attack. But their proficiency in the art was expended on the defensive.

In battle, any preoccupation other than that of the destruction of the enemy becomes one's weak point. If Admiral Jellicoe were preoccupied with the preservation of the Fleet, from whatever cause, it was, nevertheless, his weak point. If Admiral Scheer were preoccupied with the thought of his numerical inferiority, it made him weak on the battlefield far more than the actual number itself. That there occurred big chances for each Commander-in-Chief, no one can deny. Each was alike in always estimating the situation as more unfavourable to himself than it really was. I do not blame them: it is human nature. But let us call to mind that great leaders were made of sterner stuff. They rose above that nature. They attacked with numerical inferiority. They again attacked in unfavourable situations. Their strong will to conquer dominated every other consideration, dominated every other factor, dominated the enemy and won them glorious victory.

Ichiro Sato.

## CHAPTER VI.

### The Capital Ship.

The Admiralty have definitely decided that large ships are essential to the British Navy of the near future. This verdict has been endorsed by a Cabinet Committee, as indeed it was bound to be seeing that the Admiralty had the necessary technical knowledge and experience to decide such matters, whereas the Cabinet Committee could boast of neither of these essentials. On the other hand, a certain conflict of opinion has been shown to exist by correspondence in the Press. It is, therefore, well for the general public to appreciate that the Admiralty have at their disposal advisers in naval construction second to none in the world; they have the daily experience of the sea-going fleets and the opinions of every officer serving in the Navy whose views they may wish to consult. Their considered opinion must, therefore, be acknowledged to be paramount in technical matters of this nature. The country must also recognise that it is extremely inadvisable for the Admiralty to publish the reasons that have led them to their conclusions, since to do so would inevitably result in presenting to the world secret information that is the property of the nation. There are, however, several considerations which cannot be looked on as confidential, which go far to justify the decision arrived at and which it may be of benefit to recapitulate briefly.

In discussing the place which large ships will occupy in naval warfare of the future, we must recognise that the points involved are so many and varied that confusion of ideas is bound to arise unless the various considerations are kept clearly in mind and each dealt with on its own merits.

Two main questions arise either of which, if answered in the affirmative, would mean the abolition of the large ship. Firstly, Do the widely-spread geographical positions of the present first class maritime Powers preclude the useful employment of large ships in naval warfare? and secondly, Has modern war experience proved the big ship to be incapable of keeping the sea owing to the development of mines, submarines, and aircraft? The first question is largely strategical; the second is a tactical proposition, which can only be answered in the light of our experience in the late war.

To deal with the first question, we must appreciate that continental Europe, from the naval point of view, is exhausted. The Triple Alliance has vanished; France and Italy cannot, for financial reasons, rebuild their navies; Russia is no longer a Power. The theatre of naval operations has therefore shifted from the narrow

waters of the Channel, the Mediterranean, and the North Sea to the Atlantic and Pacific Oceans. How will this affect naval construction?

The conception of a naval war before 1914, so far as this country was concerned, can be summed up in a few words. It was a vital necessity to us to hold in check the battle fleet of any European adversary, and so prevent that fleet supporting vessels which could transport troops in the Channel, North Sea, or Mediterranean, or interfere with our sea commerce. And further, having held the enemy's battle-fleet in check, we could, by blockade, stop his sea communication generally and the sending of supplies to his ports. Whether great sea battles ensued from the pursuit of these purposes was purely a question of opportunity. If a fleet action could be fought, so much the better; if not, our iron grip on the sea would still be effective. The initiative, so far as battle fleet fighting was concerned, would be with the enemy; on him would rest the decision whether passively to submit to the sea conditions we imposed or to attempt to upset our mastery by victory in a sea battle. Events in the Great War followed the course that had been anticipated. At first, Germany submitted to our conditions, then tried conclusions with our Fleet and failed, and, lastly, again submitted to inactivity. The existence of our battle fleet was fully justified: without its aid we should have lost the war by having to submit to German mastery of European waters. The oceans were scarcely involved in the main struggle; their freedom for our sea transport rested directly on the outcome of the struggle in the North Sea. Small incursions and eruptions in the far oceans were suppressed locally. The heart being kept safe, the arteries successfully performed their functions.

But how about the future? The main fleets of the world are now based on Great Britain, America, and Japan, each separated by thousands of miles. Where will be the points of contact of opposing vessels? What will be their objectives? The future is obscure, and political forecast impossible. It is, however, impossible to imagine this country and the United States of America going to war; the gross blunderings that could lead to this would be a crime against civilisation. Again, war with Japan appears to be most improbable; but the fact that war appears improbable is no excuse for neglecting to keep our Navy efficient. If our voice is to be heard in the councils of the world, we must be strong. Our Dominions, Colonies and dependent possessions must have behind them a strong arm to support their just claims, and we must therefore model our Navy to suit the new conditions.

### Invasion now Improbable.

The battleship, as built for the North Sea and the Mediterranean domination, is no longer the most suitable type, except for purely European complications. A fleet of pre-war battleships must, in future, form a separate force valuable only for European operations. An improved type of large ship of considerable ocean endurance

becomes a necessity. Invasion of the main territory of the present great sea Powers is a dream of the past. No sane person can imagine either Japan, the United States, or Great Britain being invaded by troops transported and escorted for thousands of miles and landed on a hostile coast. Invasion of colonial territory is hardly more probable, unless that territory has no naval base and lies close to the invader's country. Invasion and fighting on neutral territory are possibilities. Command of the sea will, as heretofore, be felt mainly in commerce restriction. In a war on commerce, the same principles will hold good in the future as in the past, but unless bases are occupied and equipped within easy reach of the territory of a belligerent—a most difficult operation in war time—close blockade of his harbours cannot be undertaken, and war on commerce will take the form of raids rather than the more stagnant blockades of history. This argues squadrons of cruisers to raid or protect the ocean routes, or large submarines to lie in the vicinity of the principal lines of traffic. The former will probably be the more efficient, since a fast squadron spread out can sweep a far larger area than can be accomplished by a division of submarines with their limited speed and powers of observation in average weather. The capture of vessels, as differentiated from mere sinking, and the disposal of their crews, is far more easily effected by surface than by submersible vessels. If raids of this nature be carried out, opposing sea forces must seek out and hunt the raiders, in which case either the raiders must run or fight. If they are to gain safety by flight, their speed, in average weather, must be greater than that of their pursuers and their endurance high. Such tactics never can command final success in war. If they fight, then their vessels should be more heavily armed than those of their opponents. This argues inevitably the use of the largest and fastest cruisers that construction can supply and financial considerations permit. The law of sea fighting is unchanging and unchangeable. Other things being equal, victory goes to the superior armament. Nothing will alter this, so that, whether in the narrow seas or open ocean warfare, the large, heavily-armed ship in surface battle will win the day.

The main difference imposed by ocean warfare is a modification of the design of capital ships so that speed and endurance are obtained at the expense of armour protection and increased tonnage, but all strategical considerations lead inevitably to the conclusion that such vessels will be required by our Navy for many years to come.

## The Future of the Capital Ship.

In order to answer the question whether the capital ship is able to keep the sea in the face of submarines, mines, and aircraft, we have primarily to depend on the experience of the past. Were this all, the task would not be difficult, and opinions among naval officers would differ only in the exact reading of the lessons past events have provided. There are, however, two factors which have, in addition, to be considered which materially add to our difficulties. First, the question has to be answered whether the late war, which

after all is the greatest of all our sources of information, can be taken as typical of future wars, and if in such wars similar dispositions at sea will obtain, and whether the conditions at sea during the Great War gave full scope to modern weapons and tried them to the uttermost? The second problem is to forecast the development of naval armaments, both offensive and defensive, then to foresee probable improvements in each, and to balance these against each other in offence and defence—guns against armour, submarine against large ships, aircraft against floating vessels, the torpedo against modern ship construction. It is in this attempt to forecast the future that our main difficulty lies, but the difficulty of the problem is no excuse for not making the attempt.

The most marked lesson of the late war, so far as fighting ships were concerned, was the revelation that thought and foresight had provided means to defeat the newer weapons that had appeared among naval armaments. It is well to examine this more closely. The history of torpedo warfare is a classic example of how weapons, untried in war, may, in peace time, appear to be invincible and unanswerable, and yet, under fighting conditions, be found not to preponderate in the way expectation had led us to anticipate. In fact, the history of the torpedo is a standing warning against assessing too highly, in peace time, the power of weapons of which no experience has been gained under the conditions of war. In the late 'eighties of the last century, the torpedo carried by small torpedo-boats working from shore bases became a threat to ships at anchor. The breakwaters at Portland, Plymouth, Dover, Malta and Gibraltar completely annulled the threat. Meanwhile the destroyer had been designed and built to chase torpedo-boats; these were given torpedoes and, being seaworthy enough to accompany the Fleet, were able to remain at sea and were no longer dependent upon harbour refuge. The range of the torpedo grew from hundreds to thousands of yards, and therefore the torpedo developed into a weapon for use by destroyers in a day fleet action or at night on the open sea if the enemy's fleet had been marked down. The reply to this threat was an increased secondary armament of the ships, and the tactics of the fleet in case of attack. The gun, in the meantime, had developed in range no less than the torpedo, and, since the efficiency of the gun is the main factor in deciding the range of a fleet action, the increased range at which the opposing battle fleets would undoubtedly choose to commence the fight, gave time for a fleet to turn "away" or "towards" the attacking vessels and so to defeat the attack. Now before the war, the writer, like many others, was one of the most ardent upholders of the torpedo. It seemed inconceivable that if destroyers were near an enemy's fleet, either in daylight or dark, a tithe of the ships should not be reaped; but events proved the opposite. The counter stroke by other destroyers, the visibility of the wake of the torpedo, the watchfulness of the Admiral, and at night covering darkness and uncertainty if ships met with were friend or foe, robbed, in stern war, the torpedo of its anticipated success, so that the destroyer and torpedo, now that they have passed through the ordeal of a great war, must merely take their place in

the category of weapons which largely affect naval dispositions and exercise a restraining control on the tactics of fleets, but they cannot be looked on as determining factors in large ship actions, since that control, when exercised, provides an antidote which robs them largely of actual material achievement.

### Submarine and Aircraft.

As with the destroyer, so with the submarine. Before the war, prophets loudly proclaimed that fleets would have to remain in harbour or be sunk. This was proved not to be so. Our Grand Fleet steamed in the North Sea a distance equivalent to a triple circumnavigation of the globe without the loss of a single ship from attack by a submarine. Again, defensive precautions robbed the new weapon of its terrors. It was found merely to exercise certain minor limitations on the free action of the Fleet.

With aircraft, the case was somewhat different, in that the war may be considered as having given birth to aircraft. Before the war they were purely experimental; during the war they grew rapidly and waxed strong, but in offence against ships were proved to be futile. On the Belgian coast, up to the end of 1917, scores of attacks were made on our vessels and hundreds of bombs dropped, but only one bomb struck a ship under way. The submarine mine was no more successful, only one capital ship of the Grand Fleet, and a very small percentage of other men-of-war other than the vessels employed in sweeping operations, were lost by this new weapon. So that, summing up this brief review, we are forced, almost with surprise, to the conclusion that in the late war all the new weapons of offence failed to realise the expectations formed of them. We say almost with surprise, since the verdict arrived at is greatly against our previous anticipation.

Now had these weapons a fair chance in the late war? Were there special conditions unlikely to recur in the future which hampered them and reduced their offensive value? The ardent advocate will always find excuse for failure; zeal is apt to gloss over the difficulties which militate against realisation. But let us briefly review the past conditions and see where the failure of each lay and whether future improvement will banish these and raise the weapon superior to the causes of defeat.

### No Change in Strategy.

Strategically at sea the late war was an echo of the wars of one hundred years ago. Blockade occupied most of the fighting period and was the general condition. Fleet engagements were rare. The blockade of 1914–18 differed chiefly from those that preceded it, in that the blockading fleet carried out the blockade mainly at anchor in harbours. Steam had endowed the navies with a certainty of movement that was practically independent of weather. Fuel endurance had limited the range of action and the time a blockading fleet could remain at sea steaming at a speed sufficiently great to

annul the threat of submarine attack. Wireless telegraphy had abolished the time element in transmitting information as to any movement on the part of the enemy. It was recognised that it was quite useless for a fleet to put to sea, training purposes excepted, unless it had some definite object in view. The only objectives of the German High Sea Fleet were to fight and beat our Fleet, and so raise the blockade or to defend an over-sea expedition. Neither of these objects were furthered by our Fleet lying in harbour ready to move. When the German Fleet put to sea, our Fleet put to sea also. The one difference which distinguished the new from the old blockade —*i.e.* lying in harbour instead of off the enemy's ports—was therefore only a variation in tactics but not in strategy. To the public, however, it of course appeared that our Fleet was doing nothing, since they were accustomed, from historical parallels, to picture our Fleet lying off the enemy's harbours. The potential value of a battle fleet is none the less, whether it is in harbour or at sea.

If the enemy has large ships, we must have them also; otherwise he will be able to control important portions of the water and drive from it all weaker surface vessels, unless vessels exist which, while navigating below water or up in the air, can prevent our large vessels from occupying those waters. The advocates of submarine warfare claim that their vessels can effect this. On what is their claim based? The evidence of the late war is against them. Adequate destroyer screens prevented successful torpedo attack on the main fleets. In reply, they claim that the late war was not a fair test. This can hardly be conceded. The German submarines had ample opportunities of attacking our fleet. It is true that our submarines had no fair chance of attacking the German High Sea Fleet, but will they in future be afforded a better chance against the enemy? Will the strategy of the weaker fleet differ from that adopted by the Germans? The primary difficulty of bringing the submarines and their surface enemy into contact will always remain. The inherent disabilities of a submersible, when on the surface, militate against seizing a suitable opportunity for attack, and the limitations of submerged navigation, both as regards range of vision and speed, make it almost impossible for a submarine to regain position should the enemy alter course. Real co-operation of a submarine with its fellows when below water, is, at present, visionary. We must remember that the Germans, who were great experts in submarine navigation, never concentrated their vessels in attack on our Grand Fleet, although the destruction of a tithe of that fleet was of the greatest importance to them. They had balanced the practical difficulties against theoretical claims. In dealing with all new weapons, let us not forget the history of the destroyer armed with the torpedo—theoretically invincible, practically largely impotent.

With aircraft it is the same. Claimants to the invincibility of air attack usually fail to draw the analogy between fighting in the air and on the surface of the sea. In their vision of offence, they neglect the countering defence. The attack on ships by bombs can be carried out only by aircraft less swift and handy than the fighting machines that protect the fleet. The bombers must be protected by

a flying escort. All this is a mere repetition of surface fighting with one exception—namely, that the bomb is one thousand times less efficient than the gun. A bomb starts without any velocity and having picked up every error inherent to slow motion through the air, gathers velocity when it has firmly settled itself on an erratic course. At the risk of perpetrating a "bull," we may say that the muzzle velocity of a bomb is at the wrong end of its flight. Until aircraft are strong enough to stand the recoil of a discharge commensurate with that of a gun firing a projectile as heavy as the bomb, so long will bombing be ineffective against a small area such as that presented by a ship, especially a ship moving through the water. The attack by aircraft carrying torpedoes is even less dangerous. Not only have they all the disadvantages of the bombing machine, but they must descend to within thirty or forty feet of the water, otherwise their torpedo would be damaged by the blow it receives on being dropped on to the water. At such a low altitude, the aircraft has lost its main security against gunfire, namely, height. Instead of being a body in space, it becomes merely an ordinary surface target and on losing the complication its height imposes on anti-aircraft gunnery, it should stand but a small chance against modern gunfire. Even if the torpedoes are successfully dropped they can be avoided unless discharged at a practically impossible short range. All such attack with torpedoes in harbour can be frustrated by means which are so simple and apparent as not to require mention.

### Development of the New Weapons.

The new weapons, therefore, have their counterparts in attack and defence with ordinary surface warfare. They have no claim, at all events in their present state of development, to exceptional powers. The question still remains: Can these powers be augmented so as to make them really deadly?

The limitations of the submarine, which make it inferior to the destroyer, are matters of speed in attack and inability to work in co-operation with its fellows. In order greatly to increase submerged speed, some new form of propelling energy is required; until this is invented further criticism is unnecessary. So also with concerted action. To a human being in a vessel travelling at high speed nothing can approach the efficiency of untrammelled vision; no instruments however ingenious or efficient can make up for partial blindness. The two fundamental limitations of the submarine, which make it inferior to the destroyer, seem likely to remain undiminished for many decades to come, whereas its one advantage—viz. invisibility during approach—can never be improved; it never can be more invisible than it is to-day. For these reasons, one need not expect the submarine to be more deadly against large ships in future wars than it is to-day.

With aircraft the same line of reasoning applies. Defensive measures with protecting squadrons of fighters will advance with offence. No reason exists why the war in the air should not progress on the same lines as that on the water. Keep the analogy of the

surface attack by destroyer and the aerial attack by the bomber clearly in mind, and see how the defensive measures against the one on the surface of the water indicates the defensive measures to be taken against the other in the air. But one disability in attack must be noted. The bomber must be less agile than the fighter and, therefore, more at its mercy, unless supported by fighters also. To translate this so as to obtain a strict analogy, we must imagine heavy, slow, torpedoing destroyers protected by light fighting destroyers, a condition distinctly unfavourable to successful destroyer attack.

So far, therefore, we may confidently expect the large ships to continue reasonably safe from destruction by the newer vessels of war. Over and above all the preceding considerations, we have the factor of improved naval construction. Large ships can now be built so as to be practically immune from the explosion of a torpedo, and in fact from successive explosions of several torpedoes. This, of itself, goes far to abolish real danger in torpedo attack. Such vessels are very large and exceedingly expensive. This increased cost necessitates building fewer numbers, but does not argue building none at all. It may be claimed that the explosive charge of the torpedo can be increased so as largely to annul constructive defence. In this we are up against the old gun and armour problem—defence and offence progressing and each in turn obtaining the mastery. The subject is too technical to deal with here, but increase in explosive charge of the torpedo to an amount necessary to defeat modern construction will mean a very considerable increase in weight of torpedoes, and consequent increase in size and complication of the vessels carrying them. The increase in size of the torpedo may well prove more difficult and expensive than the *pro rata* increase in ship protection. With the exact methods of constructional defence we are not concerned—whether the bulge should merely exist at the waterline or be carried up the height of the ship is a matter to be decided by conditions of stability, weight, and expense. Suffice it for our purpose that adequate protection against reasonable torpedo attack can now be provided. We are therefore forced to the conclusion that the newer weapons provided by progress in science and construction, have not in any way pronounced the doom of the capital ship. Nor has modern redistribution of sea power reduced the necessity for our building large ships to protect our world-wide interests.

REGINALD BACON.

## CHAPTER VII.

### THE POTENTIALITIES OF THE TORPEDO.

THE lamentable failure of Naval writers, and of any strong body of Naval opinion, to visualise the changes that were taking place in the conditions of war at sea during the years 1904-1914 is worth examination as a warning. Though many observers will look for improvement from the new War Staff, it must be remembered that the members of such staffs possess all the national characteristics, and since the cause of the failure is believed to be merely the ingrained conservatism of our race, always very strongly marked in naval affairs, there is a great danger that all the War Staff may do is to enforce the national objection to change, whilst criticisms of their doctrines are certain to become irreverent.

Certainly this was the German case. Both ashore and afloat they had a War Staff *de luxe*; their doctrines on naval matters—based largely on ours, as a result of our prestige—were just as wide of the mark as our own, but being issued under the ægis of the Staff the ruling was final. The argument was, and often is still, that naval warfare must be judged by results, not by particular incidents, and there is certainly a danger, when it is claimed that certain incidents cannot be repeated because of imaginary or untried improvements in material, that the whole doctrine of war experience may be reversed, whereas a proper consideration of the inevitable "counter," equally available to the imagination, would have left the results untouched.

Nevertheless, a forecast based solely upon the net results of the last war is open to grave error. History will never repeat itself in this respect in detail, for the inter-relation of the various weapons with which war is now waged is so delicate that apparently small differences in strategical situations and even such matters as average range of visibility are liable to produce very great differences in results.

The torpedo made its debût in the Russo-Japanese war and achieved practically nothing. Only 2 per cent. of torpedoes fired against moving ships found their mark, and the official verdict, revealed in the war colleges and reflected in the schemes and rulings of our peace manœuvres, was, that the torpedo would remain of very minor importance. Naval decisions were to be obtained, as in the past, by means of artillery actions between surface ships. This pernicious teaching was responsible for the loss of thousands of lives and much damage to our naval prestige when war came again, for, the torpedo and the mine having been belittled, our ships were not

properly designed to withstand under-water explosions, and inadequate precautions had been taken to guard against attack from submarines.

Advocates of the seriousness of the menace pointed out in vain that there were special circumstances of climate and personnel in the previous war that would not occur again. The Japanese were admittedly lacking in trained torpedo ratings, and often, though the greatest heroism was displayed in bringing their torpedoes into action, failure resulted from avoidable causes. Further, since no submarines were employed by either belligerent, the torpedo lacked its most efficient means of getting into action and its most reliable form of discharge.

### The Moral Influence of the Torpedo.

The torpedo has never been, and never will be, a weapon of precision, whether fired at short range at a single ship or in numbers against a fleet of ships. The always uncertain factor of "speed of enemy" and the small difference in speed between that of target and torpedo will always cause this to be so.

In the first case, the attack and accurate judgment of enemy course and speed are inherently difficult; in that of long-range massed fire "into the brown" the slow speed of the torpedo is the cause, both of these and the visibility of the tracks of existing torpedoes rendering avoidance possible by alteration of course, were the principal reasons in the last war.

The universal adoption of a high sea-speed, destroyer screens, and the practice of always steering a zig-zag course have tended further to decrease the chances of a direct hit, even allowing for the fact that the number of torpedoes that can be fired from one submarine in one "salvo" has increased from two to four and in many cases to six. Though it is possible that this balance may be redressed in the near future, as will be described later in forecasting probable improvements in material, the dominating influence of the torpedo is undoubtedly a moral and an indirect one. It is not always realised what a tremendous influence this is and what a phenomenal effect it has had upon all naval operations, due entirely to the advent of the torpedo-carrying submarine. The moral effect of a heavy gun is great, but the gun must be in sight; when it is not the influence disappears, and it is non-existent for all ships possessing speed greater than that of heavy-gun-carrying ships.

In the case of submarines, however, it is only necessary for one belligerent to possess quite a small number of such vessels, which need not even be at sea, to cut down automatically the endurance of the whole of the enemy's surface fleet to that obtainable at high speed on a zig-zag course. Their potential value is such that their mere existence is sufficient to reduce the sea-activity of all surface ships by varying amounts, usually more than a half of what it would be if there were no submarines opposed to them. Capital ships and valuable cargoes are further restricted by having to be protected by large numbers of destroyers, and a universally restrictive effect is thereby produced on all the naval operations of surface war vessels

which is at times so great as to render them impossible. The Japanese attack on Port Arthur, and the Allied attack on the Dardanelles are two cases in point; neither of these operations would have been undertaken in the face of modern submarine opposition.

In the last war this restrictive effect of the torpedo on our Grand Fleet was not sufficient to prevent it carrying out a distant blockade of the German surface fleet, owing to the small distance separating the two fleets; but in the future if our enemy, as appears certain, is much more favourably placed geographically, the effect, coupled with that of the torpedo-carrying aeroplane and mining operations on the scale that war has shown to be possible, will be so great that, in the opinion of many, it will have the result of rendering the present capital ship useless.

## The Direct Influence of the Torpedo.

If a bald statement of percentage of hits to torpedoes fired, or of the numbers of ships sunk by torpedoes in the last war, was any criterion of the future of the torpedo in the next war, one could say at once that the next war will be entirely dominated by under-water weapons, for the results achieved by the torpedo in the last war make those obtained by the gun, or any other means, appear insignificant. Our own Naval Service lost 131 vessels from torpedoes and mines, whilst the losses sustained from gunfire were only 29, which is only a little more than half of those lost during the four years by collision and grounding! Our losses in auxiliary ships, vessels under Admiralty charter, such as ammunition, mine and store carriers, Fleet messengers, oilers, and so on, amounted to over 500 from submarines and mines. Submarines sank over 190 of our fleet colliers alone!

The inference is obvious if we desire in the future to maintain a Grand Fleet abroad, for these vessels formed a part of the lines of communication of our surface fleet which was in home waters. By gunfire, the only losses in this class of vessel were a few drifters, about half the number that were lost in collision and not so many as those stranded.

In merchant ships the havoc wrought was terrific—from submarines 2,100 and from mines 250. To the above must be added the losses of neutral ships—from submarines 3,050 vessels, and from mines 320. The grand total of losses from submarines and mines for four years of war amounted to 6,350 vessels. This is an average of 130 a month.

The figures deserve close scrutiny in themselves and in the circumstances under which such great results were produced. It should be noted, firstly, that for the first year the results were small; the number of submarines available at the commencement of war was almost negligible; the whole of the enemy's submarine fleet, personnel and material, had to be equipped and trained after the war commenced, so that the active period was certainly no more than three years at the most, bringing the average sinkings up to six a day.

This by itself is sufficient reply to the often repeated charge that no modern capital ship was sunk by a submarine. Not only were the latter too busy, but the German demand was for "Tonnage." All effort was concentrated on this. German submarine officers were strictly enjoined not to torpedo men-of-war, and no serious effort was ever given to torpedo attacks on our surface fleet.

Secondly, it is remarkable that the losses which were suffered by various classes of warships were quite independent of size, speed, or any distinctive feature; they were simply proportional, not to the actual time spent at sea, but to the time of employment at sea on some operation other than that of a simple passage from port to port.

Commencing with battleships, out of a total of 11, 7 were sunk in 1914–15, 3 in 1915–16, 2 in 1917–18. The larger numbers early in the war were due to their employment at the Dardanelles, *i.e.* they were outside a defended harbour and not making a passage—in plainer language, they were "doing something." After 1915 they remained of potential value as part of a force employed on a distant blockade, but were not actively employed at sea as they were before. In cruisers the same thing is seen. In Naval cruisers proper, after the lessons taught us by the sinking of the three Cressys, the Hawke, etc., these vessels were withdrawn from submarine-infested areas, their place being taken by armed liners, and since these vessels were continually at sea, and "doing something," they at once began to suffer heavy loss, no less than 14 of these splendid vessels being sunk—more than half the total force. The same applies to armed boarding steamers, gunboats and sloops, vessels necessarily constantly at sea and so again suffering losses in proportion. An exception may perhaps be made in the case of very nimble ships such as destroyers, torpedo, and patrol boats. These vessels were constantly at sea and "doing something," yet no more than 30 of them were torpedoed or mined; their shallow draught no doubt saved many.

It may appear a platitude to say that the more a vessel is at sea the greater the risk she will run, but there is a subtle difference in correctly estimating the influence of torpedoes or mines in considering whether during the time the vessel is at sea she is merely on passage, or whether she is actually—what, for want of a better covering description, may be called "doing something." The menace from submarines' torpedoes or mines is not great when ships proceed at speed and pass only once, or at most twice, through an infested area. In the case of mines the best example is afforded by the heavy losses our own submarines suffered. Mines will always break away and drift about, and though our submarine patrols were placed in as safe positions as possible, they suffered constant loss simply due to the fact that since they inhabited a comparatively small area for about a week, if there was a drifting mine about they stood a great risk of finding it, whereas the chances of a ship bumping the truant mine during the course of single passage through the area would be remote.

So also in the case of a submarine's torpedoes, in numberless cases a successful attack has been preceded by hours of patient stalking.

If the target merely passes quickly through the submarine's area she is reasonably safe, unless the investment is so dense that she must pass several; but if she returns, particularly without having gone out of sight, or once more if she is "doing something," in which may be included holding up merchant ships for visit, patrolling, watching a port, bombarding, covering a landing, and in fact any known naval operation, other than a rapid dash out and back to a base, the danger increases very rapidly.

Before proceeding to discuss how far these outstanding lessons of the influence of torpedoes in the last war may be reproduced in the future, a short examination will be made of the special circumstances attending the late war.

### The Special Circumstances attending the late War.

Briefly the dominating factors in the late war against Germany may be said to have been the geographical conditions and intelligence. The former enabled us distantly to blockade the enemy's surface fleet; the latter was of such quality that roughly speaking we knew not only the position of every enemy ship, but every movement of those ships. Our splendid position right across the enemy's exits then came in again, in that it enabled us, or should have enabled us, to counter every movement made by the enemy. The inevitable result of this was that the enemy's surface fleet became paralysed, and so far as the future influence of the torpedo is concerned it need only be considered in so far as it affects the comparative losses by torpedo and gunfire. Since the enemy's surface fleet was hardly ever risked, it must follow that there could not be many losses from gun-fire, since our surface fleet had no targets. The enormous preponderance of damage done by torpedoes, over that inflicted by guns, in the late war was therefore due mainly to this fact and not to any superiority of the torpedo over the gun as an effective weapon. There is, in fact, no comparison of this kind possible as the spheres of the two are so entirely distinct. It is merely a question of opportunity, and the facts only show that the opportunities for using torpedoes were enormously greater than those which occurred for using guns.

Though an examination is made of the results of the last war, as one of the means of arriving at a sound conclusion of the influence of the torpedo in a future war, the main point to be kept in view is to try to see whether the opportunities for using the torpedo are likely to increase or decrease, and whether full advantage was taken of such opportunities as occurred in the last war.

### The Ultimate Naval Problem of the Future.

Though it appears, at first sight, a hopeless task to forecast the influence of the torpedo in a future war that is so vaguely defined, it is not difficult to find certain factors which are definite and sufficiently non-controversial as to indicate the future with some certainty.

It is not necessary to define with whom we have to contend for our existence, for that of any of our possessions, or in the defence of

any treaty to which we may be a party. Whatever the cause and whoever the enemy, it may be taken as certain that we shall not go to war again on the grand scale without the ultimate stake eventually becoming our continued existence as an empire. Before the last war, it was insisted by some, and correctly so, that if Germany wished to impose her will upon us, there was one and only one road open to her, and that was by cutting and keeping severed our sea-communications.

Invasion, it was argued, had become more and more difficult. Her surface fleet was inadequate to enable it to compete with ours, and so there remained only one way of bringing us to defeat and that was by a submarine war on our trade. These arguments have as much force now, and apply with equal certainty in the future. The already immense difficulties in the way of invasion have been increased manyfold by the advent of tanks, aircraft, and mechanical transport, to mention only three of the complications which the last war produced. There is only one other way in which a future enemy can reduce us to defeat to the extent of surrendering even a part of our empire, and that is by the means recently attempted by Germany though not necessarily by precisely the same methods.

A local gain of command of the surface in the Far East would not suffice, supposing, for example, the possession of Australia was at stake. This whole continent might in fact be occupied, but the matter would not end there. Ultimately it could only be held if the local command was extended to these islands in sufficient strength to cut off our supplies of food and other necessaries.

The question of the persistence, or otherwise, of capital ships, and fleet battles for a partial command of the sea, is still unsettled, but it is not in dispute that whether capital ships are built or not, whether they do or do not fight, and whether ours win or lose the fight, attacks on our sea trade can proceed as they did in the last war; and this is for us " the last ditch."

The vulnerability of merchant ships in the face of new weapons is beyond question the vital matter for us concerning a future war, and their protection should be our first thought. The day has passed when our object could be achieved by "seeking out and destroying the enemy's fleet," or even by an effective blockade of his surface ships.

We may or may not be able to achieve either of these objectives —perhaps aircraft will provide the means. If we cannot do either, we shall have to compete with attacks on our trade from surface ships as well, in which the influence of the torpedo will not be felt, but whether we do so or not, the real menace is the submarine one. Nothing that we can do can remove that; it will have to be faced whatever else may happen. It must always be more acute than the depredations of surface raiders, which can be much restricted if we keep a strong submarine and cruiser fleet.

As in the last war, therefore, the submarine is certain to be the cause of all our troubles in the future, because it is by far the most efficient weapon for striking us in our tenderest spot, and since the submarine is essentially a torpedo-carrier, the torpedo, or rather the opportunities for using it, will predominate.

### The Conduct of the late Submarine War.

There is a tendency to believe that we know all about a submarine war on commerce, and, after our recent experience, how to compete with another, but this unfortunately is the very opposite of the truth. The late submarine war was conducted in an original manner, in direct contravention of the existing maritime law and geographically under most difficult conditions. It consisted in its most usual form of torpedoing ships without warning, whatever their nationality, if they entered certain danger zones, notices of the limits of which were given beforehand by the enemy. The submarines used were torpedo vessels of very low gun power on the surface, which enabled us to worry them with any and every small surface vessel we could lay hands upon. Yachts, launches, trawlers, even sailing ships, were all useful, could act without support in hunting them off the surface, and either attack them with depth charges when they dived or else drive them on to deep minefields. Our splendid geographical position made it necessary for hostile submarines to pass our patrols on their way out and back from the trade routes, on courses that were pretty accurately known, whilst all these patrols were quite short distances from their bases and in no fear of molestation from enemy surface ships. The employment of the torpedo and the effective blockade of the enemy surface ships, enabled us also to obtain great relief from the establishment of convoys for all ships in the Mediterranean and North Atlantic, and again our position enabled us to give those convoys strong protection with destroyers and other light craft just where they needed it most, without the necessity of giving the convoys any other support. The only exception to this was the Norwegian traffic, where battleship support was at times necessary and available, but this was a trifling matter compared to the great convoys entering the English Channel.

### The Convoy Question.

Due to these reasons, there was no doubt in the last war as to the efficacy of convoy, but in the future the necessity or otherwise of convoy must be a very vexed question.. For attacks on trade by torpedoes fired from submarines, convoy is excellent, but for some other forms of attack it is the worst thing that can be done. One great objection to it is, that it relieves the attacker from all obligation to carry out the laws as to visit and search of ships and the removal of the crews to a place of safety before destroying a prize.

From the moment we put our trade into convoy, the German submarine attacks on them became perfectly legitimate. The presence of an armed cruiser or destroyers as escort implied an intention to resist, whilst the practice of steering a zig-zag course was an actual act of resistance. The collection of ships in convoy enormously speeds up losses if the convoy is intercepted by superior force, and since it appears that our chances of blockading a hostile Fleet again are remote, we arrive at the unfortunate result, of which we have no experience at all, that whereas submarine cruisers which may be met

all over the world will demand universal convoy, the very fact of putting ships into convoy will legitimise the torpedoing of ships without warning, will enormously facilitate night attack by surface and submarine cruisers and day attack by enemy cruisers in force, since so many convoys can never be adequately protected.

This chapter is confined to the future of torpedo warfare, and therefore the question of gun attack on trade is not strictly relevant, but it is impossible to separate the two in considerations of convoy, particularly where submarines are concerned, and it appears quite certain that the most serious menace to our Empire in the future lies in an attack on our trade by means of submarine cruisers in conjunction with submarine torpedo vessels. Such a campaign will further modify the experience of the last war in that the auxiliary patrol as we know it by swarms of small, lightly-armed craft will not be available, for you cannot keep such vessels out without support on the spot, when submarines with a good six-inch armament are liable to come to the surface at any time.

The instalment of plant for cooling and drying the air will enable submarines to operate in the tropics instead of confining them to the Northern half of the Atlantic and the Mediterranean as in the last war.

The capacity of a submarine commerce raider, which it is now open to any one to build, is such as to enable her to operate without support for six months up to 20,000 miles from her base.

It is not a fact that such a vessel is necessarily a clumsy diver and difficult to manage. She can be just as elusive as the standard torpedo-carrying submarine.

### Future Developement of Torpedoes.

Though the future influence of the torpedo depends mainly upon whether the opportunities for using it will be even more frequent than in the last war, rather than in any great improvement in the weapon itself, there are certain lines of development indicated which should be mentioned, as they will, when perfected, remove many of the disabilities under which torpedoes have hitherto been used. There is no reason to expect any great advance in speed or weight of explosive carried, but, if the lessons of the war are correctly read, a throwing open of torpedo manufacture and design to a wider field should result in greater reliability and improved depth taking and depth keeping.

It may be anticipated that the wake of the torpedo will be rendered far more difficult to detect if not quite invisible, and since the milky track left by German torpedoes was very marked, even in a broken sea, this will have its result on the numbers of ships which were saved by prompt use of helm when the track of a torpedo was first seen. It will also add greatly to the difficulty of using depth charges effectively. It is an extraordinary state of affairs now that the torpedo is a daylight weapon and particularly from the submarine point of view, that a highly complicated vessel specially constructed to deliver an attack depending for success and for its own safety

upon invisibility, should be handicapped just as the final act is reached and at the most dangerous moment, by a large upheaval of air on the discharge of the torpedo from the tube. This remains for some time to give away the submarine's position, rendering the submarine liable to be depth-charged by any nimble escort, whilst the track of the torpedo assists also to this end, in addition to giving the enemy a fair chance of avoiding the torpedo.

It is such an obvious matter that no doubt it has already received attention. It is urgently required for submarines, since it will greatly increase the confidence in attack, to know that the torpedo will not be seen nor the direction from which it has come be visible, that it will be worth even a considerable reduction in "speed of torpedo."

The means of detonating the torpedo, both German and our own, were inefficient and remained so during the whole of the last war. Considering the trouble and difficulty of getting such a delicate mechanism as a torpedo to hit a target probably at high speed, it is wonderful that those responsible should be content with a pistol which, even theoretically, will not fire the charge for 30° out of a possible 180° of striking angle.

A ship's side is not a flat plate and as the torpedo may strike the swell of the bow, the counter, the curve of the ship's bottom, or one of the many irregularities on it, it is impossible to guarantee the present pistol operating whatever may be the angle between torpedo's track and path of target, an angle always tending to become acuter by reason of the target attempting to dodge the torpedo. If, as often happens, the target happens to be going faster than the torpedo, it is an even chance if the torpedo explodes even against a flat side. It is presumed that this defect will be remedied and that our future enemy will not be able to take home the warheads of our torpedoes to be made into flower pots.

The Germans employed in the last war a magnetic pistol and it must be assumed that this will be in general use before long. This will not have great effect in attacks on merchant ships, though it should slightly raise the percentage of hits to misses by eliminating all misses "under." In torpedo attacks on big ships, it will to a great extent discount the value of the blister and necessitate more protection to the double bottoms of these ships.

The number of bow tubes fitted in submarines has now risen to six, and therefore salvoes of at least four torpedoes must be expected against single valuable ships; under certain conditions it may be desirable to work submarines in company to obtain larger salvoes against a squadron of ships. There is no difficulty in controlling, by under-water signals, two, or even three, submarines, submerged at different depths to avoid all chance of collision, when salvoes of eighteen torpedoes can be fired. This is a serious menace and will be more so when the torpedo wake has been eradicated.

### THE TORPEDO-CARRYING AEROPLANE.

So far this chapter has dealt mainly with the influence of the torpedo when carried in submarines, because the latter are, at present,

the most efficient carriers and are likely to remain so for some time on the high seas, but a rival is appearing in the aeroplane which bids fair to become, in its own sphere, even more formidable.

When very fast and handy torpedo-carrying aeroplanes are produced—the type is already evolved—machines that can dive and flatten out on to their point of discharge, just as a fighting plane does now, a further heavy restriction will be placed on the operations of all surface ships within their radius of action. They require a very fast torpedo, and, since the efficiency of the attack depends upon speed and not invisibility, a wakeless torpedo is of no moment.

There can be no doubt that these aircraft accompanied by a proportion of swift planes carrying machine-guns and some equipped with smoke-screen apparatus, will render obsolete all forms of fixed permanent defences. No squadrons of ships could withstand successive attacks by them for long, even though able to bring strong destroyer escort, for the upper decks of these vessels would be shot to ribbons, leaving a clear road for the torpedoes against the bigger ships.

They are ideal in conjunction with submarines, or even unassisted, for the defence of outlying bases, or for the attack of ships or fleets in harbour wherever they can be reached. In the last war, for example, they would have stopped the reduction of Kaiou Chow and prevented the attack on the Dardanelles; the safety of ships in Italian ports, in Dover, Portland, Plymouth, all East-Coast harbours and roadsteads, including even Scapa Flow, would have been imperilled; either by day or bright moonlight these anchorages would have become unsafe.

The future influence of these torpedo-carriers will be such as further to restrict the opportunities for using guns and so will add to the dominance of the torpedo already outlined.

The balance of advantage in the probable future development of weapon technique, lies with under-water weapons as compared with any means yet in sight for countering them or with guns.

Quite apart from, and independent of, this advantage, the restrictive effect on the operations of all surface warships caused by under-water weapons of all kinds—which became such a marked feature in the concluding stages of the last war—will be accentuated by the development of aircraft.

The greater distances that for many years appear certain to separate opposing fleets of capital ships, which must always rely upon the gun as their principal weapon, will preclude distant blockade, the sole remaining function left to these fleets in the last war, and by so doing will cause the opportunities for obtaining decisive results by means of gun-fire to diminish still further if not to disappear.

This will confine naval warfare to attack and defence of sea communications, and since submarines and aircraft are the most efficient for this, the result will be that the torpedo will be the dominating naval weapon of the future.

S. S. HALL.

## CHAPTER VIII.

### Air Power and Sea Power.

It has frequently been claimed that the advent of aviation will revolutionise completely the conduct of all operations of war. During the last great struggle, the effect of the new arm was felt most strongly in land operations; in spite of its influence, however, the armies continued to fight on the principles and with the organisation laid down during peace.

In co-operation with the Army, although aircraft proved to be the only efficient means of reconnaissance and artillery observation in trench warfare, and although it gave an additional power to strike with high explosives vital points behind the enemy's lines and beyond the range of artillery, it did not seriously affect the strategy, the tactics, or the equipment of the men on the ground. The Army of to-day goes on without much thought of aviation, beyond its usurpation of the principal functions of cavalry, reconnaissance, and shock tactics against formed troops; and its ability to reach with explosives important points within the zone of operations, but outside artillery range. The Air Force of the future will, however, considerably reduce the measure of importance of the Army in any scheme of National Defence, though it may not alter the principles of its leadership, or change seriously its organisation or equipment.

On the other hand, far less experience of the working of aircraft in co-operation with the Navy and their effect on naval operations is available. On the outbreak of the Great War, the development of seaplanes was considerably behind that of aeroplanes; this, coupled with the fact that the whole of our Army was thrown into the front line almost immediately, led to the great bulk of our aerial resources being applied to the service of land operations in the early stages. The experience thus gained begat further pressing and vital demands, with the consequence that it was not until well on in the war that naval requirements and the possibilities of aircraft working with the Fleet were fully considered. Thus we must rely more on conjecture and argument in considering the effect of aircraft on naval warfare than in the case of land operations; but it seems probable that the effects on the organisation and equipment of the Navy will be more far-reaching than on those of the Army.

Aircraft in relation to naval warfare may be divided into two categories:—Firstly, those working in close co-operation with the Fleet under the direct orders of a senior Naval officer, and secondly,

those working independently on missions of destruction. The operations carried out in the first category are wholly the concern of the Admiralty, whilst those in the second will be controlled by the Air Ministry, and will often be carried out by aircraft, which, at other times, will be working against military or civil objectives. It is difficult to lay down an exact demarcation between the functions of these two categories. Some division is necessary, however, and this is not the place to discuss the benefits and evils of an independent Air Ministry and the exact scope of its responsibilities.

No fleet of the future will put to sea without a large number of aircraft—some flying with the fleet, some carried in large, speedy ships designed for the purpose, and some carried on the capital ships themselves. The services of these aircraft to the Fleet may be classified as:—

(*a*) Reconnaissance.
(*b*) Spotting.*
(*c*) Defence against aerial attack.
(*d*) Anti-submarine operations.
(*e*) Aerial attack.

### (*a*) Reconnaissance.

Reconnaissance must be considered under two heads:—long or strategical reconnaissance and close or tactical reconnaissance. Aircraft working on long reconnaissance will usually operate from the coast, as they must have considerable fuel endurance and must therefore be of large size. By virtue of its higher speed and greatly enhanced range of vision, one aircraft should be able to do the work of about seven surface craft in long-range reconnaissance on a moderately hazy day, or that of twenty on a clear day, and accomplish its task in very much less time. These aircraft would work under the direct orders of the Admiral Commanding-in-Chief, and would be in constant wireless touch with any fleets or squadrons which happened to be at sea during their reconnaissance. The best aircraft for this purpose to-day is the rigid airship; large aeroplanes and flying-boats are being designed to replace the lighter-than-air craft in this work, but given increased power and non-inflammable gas, there is no reason why the airship should not maintain its lead for some time to come as an instrument for long-range reconnaissance, where great endurance at a comparatively slow cruising speed is required.

For close reconnaissance, that is for reconnaissance in the neighbourhood of a fleet or squadron at sea, aircraft will be carried on specially designed ships, which will be under the orders of the Admiral commanding the fleet or squadron. These aircraft, fitted with medium-range wireless, will usually be limited to the work necessary for the leading and safety of the fleet or squadron concerned, and so will not require the endurance of those used in

* I use this slang expression in the absence of any more convenient naval term for the aerial observation of gun-fire.

long reconnaissance, although speed will be a very important qualification.

It may be urged that weather will frequently prevent efficient results from aerial reconnaissance; but aircraft are improving steadily in both reliability and power, and will soon be so airworthy that no greater number of failures in reconnaissance through bad visibility should occur with aircraft working over the sea and navigated by wireless, than with surface craft; in fact, their invulnerability to both submarines and mines should render aerial reconnaissance both easier and far more rapid than that carried out by ordinary methods. Thus the services of aircraft, in this respect, should reduce the large number of cruisers, destroyers, and other surface craft lately considered necessary for patrol work, and simultaneously should provide more accurate and more timely information of the enemy's movements. The immediate result of this development will be to increase the manœuvring powers of the opposing Admirals, and so, assuming that one side usually wishes to avoid a decisive action, will render the actual clash of capital ships on the high seas a rarer occurrence than ever before.

### (*b*) Spotting.

The standard of gunnery in our Navy is very high, and consequently it may be claimed that in a fleet action, aircraft will be of little value for spotting purposes. It must be remembered, however, that smoke-screens, explosions, and burning ships soon bring about a state of very bad visibility on the surface of the water, whilst observation from above, reported by short-range wireless, will, even in the clearest weather, still be comparatively unimpeded. Further, spotting aircraft are absolutely essential for fire directed against shore targets, and will make accurate practice possible in certain conditions of bad visibility resulting from low fog, rainstorms, etc. The pilots and observers of such aircraft should be directly under the Captain of the ship they serve, and should therefore be carried in her complement, the aeroplanes employed being flown from her deck and eventually landed on one of the aircraft-carrying ships accompanying the Fleet. These aircraft should be easily dismantled and erected, in order to facilitate their handling on the capital ships. Kite-balloons flown from the deck will also assist in reconnaissance and gun-spotting, but they will be very vulnerable to aerial attack. The kite-balloon is, however, merely a form of glorified fighting-top and need not be considered further in a discussion concerning aircraft.

### (*c*) Defence against Aerial Attack.

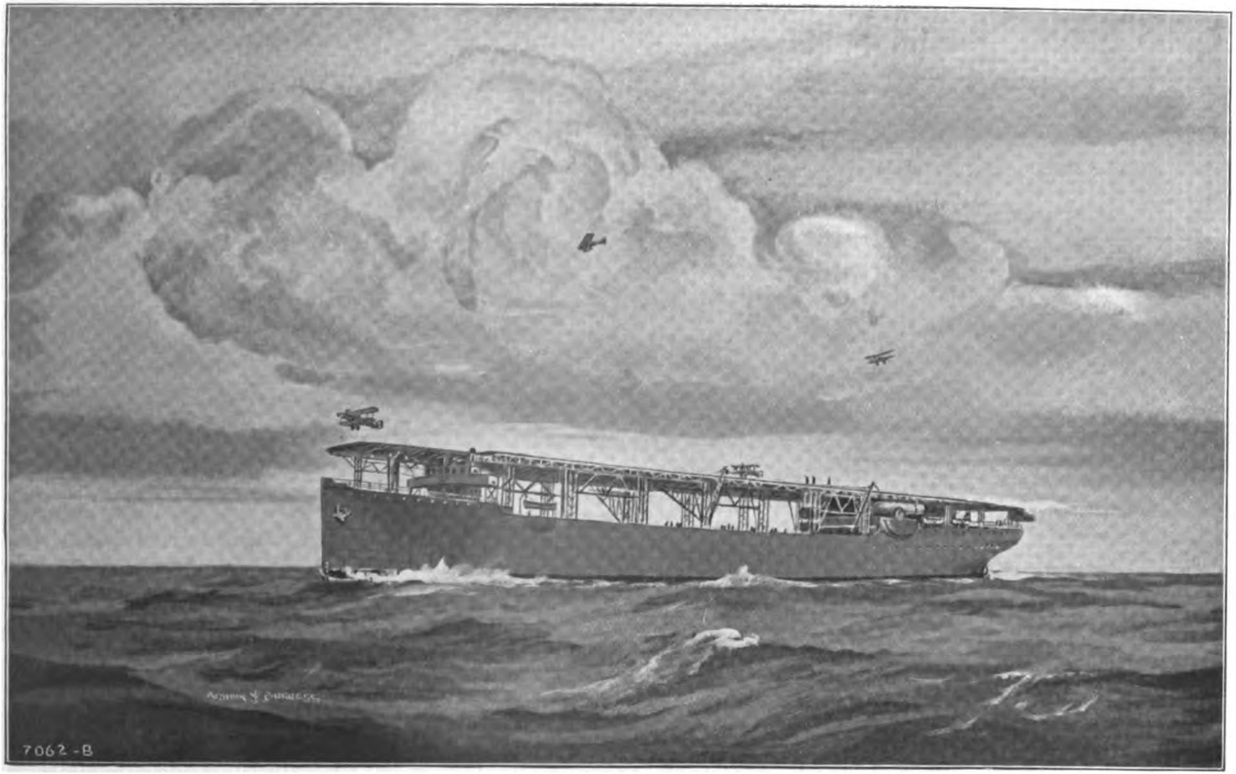
Defence against aerial attack is likely to become the most important function of aircraft working with a fleet. Squadrons cruising, or at anchor, anywhere within striking distance of the enemy's bombers or torpedo-carriers, will always be liable to sudden attack from the air, and so must be constantly protected by patrols

of high-speed fighters. This work of protection will be, perhaps, the most difficult and onerous duty of aircraft co-operating with the Navy. It is unlikely that sufficient warning can always be received of the approach of hostile aircraft to enable the fighters to fly off their carrier-ships and gain sufficient height to meet bombing attackers before they arrive over their target. It thus seems inevitable that some form of defensive patrol must be frequently flying above the ships, ready to attack bombers flying at their own height, to dive on to torpedo-carriers near the level of the sea, or to fly out and drive off aircraft armed with low velocity bomb-throwers which may be shelling the fleet from a distance. A patrol of this nature involves the provision of considerable numbers of fighters and much wear and tear to both *personnel* and equipment. The fighting aircraft employed on this duty will be carried on aeroplane ships accompanying the fleet or squadron, and will be under the command of the Senior Naval Officer. It is obvious that the protective fighters thus carried on ships must be of comparatively small size. In the past war, small-bore machine-guns were almost exclusively used for fighting in the air; in the next great contest quick-firing guns of one-inch and two-inch calibre will undoubtedly be employed in the larger types of aircraft sent to attack a fleet. They will have greater destructive effect than the machine-gun, but the low carrying-power of the small aeroplane will either prohibit their use in the defence or so limit their ammunition supply as seriously to depreciate their power to ward off a serious aerial attack. Ships will, of course, be provided with anti-aircraft guns, but experience proves that, although they make reconnaissance more difficult and force it to be carried out from a great height, they cannot be expected to prevent a serious and determined attack by a squadron of aircraft.

### (*d*) Anti-Submarine Operations.

There are broadly two methods by which aircraft can be employed by the fleet in anti-submarine operations; firstly, by employing aircraft merely for reconnaissance and attacking with surface craft by means of the information obtained by that reconnaissance; and, secondly, by finding and attacking the submarine with aircraft alone.

The first method was most generally used during the late war, and is probably the most feasible means of protecting a fleet at sea to-day. The ordinary reconnaissance aircraft accompanying the fleet can be employed on the duty, and even small airships working from the shore can be used. As bomb-dropping and shell-shooting from the air become more accurate, however, it is inevitable that aircraft, with its high speed and great range of vision, will become the attacking unit; already, at the end of the war, this system was being adopted all round our coasts. Depth charges can be dropped from aircraft flying low as easily and more accurately than from a destroyer. The near future will probably see the reconnaissance machine, which works with the fleet, designed and equipped to attack submarines and




(*From a drawing by Arthur J. W. Burgess.*)

**UNITED STATES AIRCRAFT-CARRIER LANGLEY (FORMERLY COLLIER JUPITER).**

lightly-armoured surface craft, just as is the case with the torpedo-boat destroyer to-day.

### (c) Aerial Attack.

I have placed the duty of aerial attack last, because it is under this head that the demarcation between purely Naval operations and those which will be carried out independently by the Air Force begins to become indefinite. Aircraft have three means of attacking objects on the surface of the sea—by torpedoes discharged horizontally from a low height, by bombs dropped vertically from a great height, and by the compromise of shells fired at a comparatively low velocity through non-recoiling tubes from a considerable height and range. Now the number of aircraft carried *with* a fleet must be limited by the number of ships available for their accommodation, and as reconnaissance, spotting, and defence all have to be provided for, it is fair to assume that, in the sphere of aerial attack, the Navy will confine itself to the use of torpedo-carrying aircraft capable of being flown from, and landed on, the deck of an aeroplane ship.

The precise method of employment and the extent of the destructive efficiency of torpedo-carrying aircraft has been a matter of eager discussion amongst experts for some time past, but available experience does not lead us very far towards a definite and logical conclusion. As regards the method of employment, it is safe to assume that the speed and range of these aircraft will be utilised to the utmost, and that the moment fleets are within flying range of one another, the aerial destroyers will be dispatched with the object of sinking or crippling as many of the enemy's capital ships as possible before the rival fleets join battle. The aerial destroyer of to-morrow, flying from a ship, will carry a 21-inch torpedo at 120 miles an hour to a distance of 200 miles, and that torpedo will be discharged with accuracy from a range up to 2,000 yards; the engine for such an aircraft is actually in existence and its design can be guaranteed. The means of defence available against this form of attack are: fighting in the air; a shell barrage from anti-aircraft guns; a water-barrage thrown up by the shell of the broadside guns; and armour, nets and other devices. The destructive power of the torpedo on the capital ship and the efficacy of these means of defence are two much-debated questions at the moment; I will reserve further comments on the subject until I come to the wider aspects of the aerial offensive.

### Aircraft-carrying Ships.

From the foregoing, it is obvious that a modern fleet must be provided with several aircraft-carrying ships; these must be really big, fast craft, at least capable of manœuvring with the fastest capital ships. They should have a clear deck space of at least 600 by 100 feet, and be so designed that none of the funnels, superstructure, etc., seriously disturbs the air through which the aircraft must fly when alighting. Braking devices may reduce the length necessary for alighting, but as the ships must be large enough to carry at least twenty

aircraft, must have great speed and fuel capacity, and must be able to defend themselves against destroyers and light cruisers, they must always be of considerable size.

A fleet must be provided with at least three aircraft-carrying ships; one for fighters, one for reconnaissance and anti-submarine aircraft, and one for torpedo carriers. Each has its urgent duties the moment two rival squadrons approach one another, and any attempt to make them share the same deck must lead to confusion and loss of efficiency. In addition, each capital ship will carry a small complement of gun-spotting aircraft, which must be capable of flying off the superstructure, and all of which, except the unit ready for action, can be kept unerected between decks.

## Operations of Aircraft in Warfare.

Whilst the fleet lies at anchor, long-range reconnaissance will be carried out by airships and large aeroplanes and flying boats working from shore bases. The fleet's reconnaissance aircraft will be patrolling for submarines, and small surface craft will be cruising out to sea to give timely warning of the approach of hostile aircraft; the fighters will be ready for instant action in case of hostile attack or reconnaissance. When the fleet puts to sea, the reconnaissance aircraft will increase their activities, and extend them ahead of the course ordered. As the hostile squadrons of capital ships are located and come within aerial range, the torpedo-carriers will take to the air and, in flight and squadron formations, will fly out and attack from as close a range as can be attained without reckless leading. These attacks will be continued relentlessly until either the action is over or all the torpedo-carriers are destroyed or incapacitated. Simultaneously, the fighters will commence patrolling above the ships and in the direction of the enemy, attacking all hostile aircraft which venture within a certain distance. As the fleets close, the gun-spotting craft will be thrown into action, and fire will be opened at the extreme range of the capital ships' armament.

During the action, and in the ensuing pursuit or withdrawal, all available aircraft will be hotly engaged in the neighbourhood of the opposing squadrons. The fighters, bombers, and reconnaissance aircraft will return and alight on the decks of their carriers as their petrol runs out or their missions are completed. These aircraft-carriers will be a most vitally important and vulnerable unit in the fleet, and it seems likely that they will cruise at some distance from the battle line so as to be as far as possible out of harm's way. The gun-spotting machines, as they conclude their tour of duties, must either alight on one of the aircraft-carriers or drop into the water and chance being picked up. Casualties amongst them will be replaced and reliefs provided by aircraft hastily erected on the superstructure of their parent capital ships. Meanwhile, the long-range reconnaissance craft, working from their bases, will be covering all lines of approach to the locality of the battle, and will give warning of any naval movements outside the immediate battle zone; they

will frequently have to fight with hostile craft in order to maintain their positions and carry out their work.

### THE FUNCTION OF "WIRELESS."

It is obvious that wireless will be a most important factor in aerial work on both sides. Aircraft engaged on long-range reconnaissance, on short-range reconnaissance, and on spotting will all be using it frequently, and the latter continually. The leaders of torpedoing and fighting formations of aircraft will use wireless telephony for the control of manœuvre and attack. The introduction of these signals, in addition to those already used by the ships, will make the organisation of the wireless services throughout the Fleet a task of great difficulty and vital importance. Fortunately, recent progress in the continuous-wave system and in wireless telephony has been most successful, and with really efficient training and organisation, it should be possible to solve the very intricate wireless problem presented by a large fleet manœuvring and fighting at sea.

### PROTECTION AND DESTRUCTION OF MERCHANT SHIPPING.

The question of the protection and destruction of sea-borne commerce has not yet been touched on. In the past war, the direct escorts of big liners and convoys were usually composed of destroyers with an occasional cruiser, and, in addition to this safeguard, areas within reach of shore were patrolled by aircraft before and during the time that convoys were passing through them. So far as submarines are concerned, this method of protection promises to be equally efficacious in the future, although, as the cruising range and power of accurate bombing and shooting of aircraft increases, there will be a tendency to relieve surface craft by aircraft for these duties, as being more efficient and more economical in men and material. The success of aircraft, both in reconnaissance and actual attack against submarines, during the late war was remarkable; and it must be remembered that in quite heavy weather a large flying-boat can lie silently on the surface listening with hydrophones, and need only take to the air when a submarine has been definitely located. The chief defects of aircraft for this form of work is their unsuitability for cruising at a slow speed over great distances, and their inability to carry a sufficiently large supply of depth charges.

A far more dangerous enemy to sea-borne commerce than the submarine has appeared, however, in the torpedo-carrying aircraft. It will be impossible for merchant ships to venture within striking distance of a hostile air base; and fast aircraft-carrying ships cruising on the high seas and equipped with torpedo-carriers and reconnaissance machines working in co-operation, will be a most deadly menace to single transports or convoys, no matter how fully they may be escorted. The answer to these commerce destroyers will be to despatch to sea fast cruisers, submarines, or best of all, similar aircraft-carrying ships; or to establish a command of the sea such as

we possessed at the end of the Great War, and which practically prevented the existence of any hostile surface craft on the high seas.

### Effect of the Weather on Aerial Operations.

Throughout the preceding paragraphs the question of weather has been somewhat ignored. In the past, aircraft have been very susceptible to the effects of bad weather, but almost daily progress is being made in fighting this greatest of all the hostile influences which confront aviation. Engines are becoming more powerful and absolutely reliable, so that they can be depended on to run for long periods without fear of stoppage. Improvement in design and material is rendering aircraft far more stable, durable, and capable of withstanding the effects of the heaviest winds and rainstorms, and directional wireless is producing a system of navigation which will make flying in thick cloud, fog, and darkness, a matter of everyday routine. The crossing of hills and mountain ranges in bad weather is the greatest climatic difficulty with which aviation has to contend to-day, but this difficulty does not exist when operating over the sea. Bad visibility has always closely affected naval operations, but with the advance of the improvements now in progress, aircraft flying low over the water should never be more seriously interfered with by really thick weather than surface craft —and, indeed, will usually have a distinct advantage over the latter.

### Effect of Aircraft on Naval Operations.

The foregoing covers the activities of aircraft working in close co-operation with a fighting fleet. It is necessary now to consider what effect these new conditions will have on the conduct of naval operations, before proceeding to consider the influence of independent air operations. I write absolutely as an amateur in naval affairs, but venture to state that the following appear to be logical conclusions if the efficient operations of aircraft, as indicated above, are admitted to be possible.

(i) A considerable number of the surface craft at present considered necessary for reconnaissance can be dispensed with.

(ii) Information regarding the enemy's dispositions and movements will be more rapidly obtained and will be considerably fuller than has been possible heretofore. This new factor should give the opposing leaders a greater incentive to manœuvre, and enable the weaker force to avoid battle if it so desires.

(iii) If both Admirals wish to fight, the battle will begin earlier, and at much longer ranges, than previously, and for this reason a greater number of ships will be sunk or put out of action. The new factors of attack from the air, and improved accuracy in the observation of long-range gun-fire will increase the measure of destruction to an incalculable extent. The power and effect of attack from the air is the most uncertain factor in the whole problem, and its possibilities threaten the very existence of the capital ship in the future.

(iv) A measure of aerial superiority will give to the fleet

possessing it an advantage which may completely eliminate defects arising from inferiority in the power and numbers of its surface craft. A powerful and efficient fleet, blinded by the destruction of its reconnaisance and spotting aircraft and attacked by numerous torpedo-carriers of sufficient power to brush aside the defence of its fighters, might well be defeated by squadrons considerably inferior in every respect except in the efficiency of their air units. It is this possibility which again calls into question the exact potential value of the capital ship.

(v) Finally, to sum up very briefly, aircraft will not affect the generally accepted principles of organisation and operations in naval warfare, except as regards the one great question—the power of aerial attack against capital ships. An endeavour will be made later to estimate the results of this new factor.

### Independent Aerial Operations.

It is now necessary to consider the effect of independent aerial operations on naval warfare. In accordance with our present policy, such operations would be carried out under the orders of Air Officers, and directed by an Air Ministry. The ultimate objective of an Independent Air Force will be the destruction of some vitally important organisation on sea or land, but air squadrons will certainly have to fight in order to carry their operations to a successful conclusion. Practically the only available experience of such operations was gained in the attacks by Zeppelins, and in a few cases by Gothas, on England, and our attacks on the Rhine Valley from the neighbourhood of Nancy. The destructive effect of the Zeppelins was small owing to their vulnerability and consequent very cautious handling, but the few ventures of the Gothas proved far more destructive. Our attacks on the Rhine Valley had hardly begun when the war ended, but considering the small number of aircraft employed, they proved remarkably effective. In all cases, the moral effect, and consequent dislocation of transport and manufacture, was very great indeed. Our experience points definitely to certain facts—the operations of a well-led and properly trained formation of high-speed powerful bombers are not seriously affected by anti-aircraft gun-fire. Such a unit can reach its objective in spite of any efforts that small and lightly armed aircraft can make to stop it; and it can operate efficiently by night. The most obvious defect of air attacks during the war was lack of accuracy in the actual dropping of the bombs.

In discussing the work of aircraft in close co-operation with the Navy, I have confined myself to the conditions of the present and of the very immediate future, but in considering the development and capabilities of an Independent Air Force, it will be legitimate to look somewhat further ahead. There will be many calls on the activities of the Air Force as an offensive weapon. Tempting objectives will be plentiful, and will include the enemy's seat of government, his great railway centres, his most important factories and industrial districts, the billets of his main army reserves, his

principal aerodromes, his naval bases and submarine docks, and last, but not least, his fleet. The selection of the most important objective will be a matter of national policy, and must be made by the Government. It is only the last two objectives that affect our subject.

### Future Developments in Aircraft.

It is now necessary to make some assumptions as to the developments of aircraft in the near future. The most serious weaknesses of aircraft during the War were lack of carrying power, unreliability due to weather, and inaccuracy in directing the flight of bomb, shell, or torpedo. All these weaknesses are passing phases, and steady progress is being made towards their elimination. Already, with an existing engine, it will be possible for an aeroplane to fly 1,000 miles with one ton of bombs at 100 miles an hour. It is therefore safe to assume that, in the next few years, an aeroplane, or a large flying-boat, will be able to carry five tons of explosives 2,000 miles, at a speed of 120 miles an hour, or to cruise slowly with the same weight for 30 hours. If a lesser radius of action were sufficient, greater weights of explosive could be carried instead of a proportion of the fuel, and *vice versâ*. Aircraft designed to fly slower, could carry far greater weights than these.

Airworthiness is making rapid strides in progress, and the aircraft of the near future will fly in any weather fit for a ship to put to sea; in fact, it will have the ȧdvantage of being able to fly freely above fog when surface craft are in imminent danger of collision. Improved compasses, directional wireless, drift indicators, and experience will render the navigation of aircraft as accurate and dependable as that of ships.

### Methods of Attacking Objectives.

As stated before, there are broadly three methods of attack on a fleet or dockyards from the air: bomb-dropping from a great height; firing medium-velocity shell from a considerable height and distance by means of a non-recoil tube; and discharging torpedoes, delay-action bombs, or depth charges from a low height. Of these, bomb-dropping is the simplest and oldest established, but it is the most inaccurate. At the end of the war, however, we were just on the point of producing a new system of sighting, which should certainly give the bomb dropped from a great height an equal measure of accuracy to that of the heavier howitzer on land. Such fire will be quite sufficiently accurate for the attack of dockyards and submarine bases, and will be a most serious menace to the comparatively small target presented by a capital ship from a great height.

The second method, that of launching a shell from a non-recoil tube, never got beyond the experimental stage during the war; it is necessary to design an aircraft specially for the launching apparatus, which consists of a long tube absorbing all recoil by means of a counter-charge. Twelve-inch shells, with 1,000 feet per second

muzzle velocity, can be projected at any desired height and from a proportionate range from the target, and a high standard of accuracy is claimed. Such a method of attack would have the advantage of avoiding anti-aircraft fire to a great extent, if not entirely, and might well be delivered before the hostile fighters could interfere.

The third method, that of flying low, will entail the greatest number of casualties, but obviously, at the moment, it is the most effective and decisive method of attacking ships, particularly when at sea. Bombs or depth charges can be dropped with great accuracy from low heights—say, one hundred feet; the precise effect of a heavy delay-action bomb on the deck of a capital ship or a 5-ton depth charge close alongside still remains to be discovered by experience. In America, attacks have actually been made on a battleship with 1,000-lb. and one-ton bombs with considerable results, and the depth-charge form of attack was credited with being the most effective in these experiments. The Americans, however, are still considerably behind us in air experience and design, and, at present, the most attractive weapon is the ordinary 21-inch torpedo.

The initial difficulties of dropping a torpedo from the air have been overcome, and it is safe to say that this weapon can now be discharged from an aircraft at a low height from any range up to 2,000 yards, with an accuracy at least equal to that of a destroyer and greater than that of a submarine. In fact, by virtue of a steadier platform and a better range of vision, the accuracy of fire from the air should certainly be greater, in the future, than from any surface craft.

The above assumptions are not rash statements, they are all perfectly certain developments, and will come about remarkably quickly if money is available to stimulate progress. It is, therefore, clear that the aircraft of the immediate future is the most serious problem before the Navy at the present moment, and that aviation threatens to alter radically the whole of the values allotted to the various types of surface-craft to-day.

### Defence against Aircraft.

Before attempting to deduce the results of these developments, it is necessary to consider the methods of defence against aerial attacks on fleets and their naval bases. These may be divided into three categories—nets and armour, gunfire, and fighting aircraft. The first two may be described as forms of passive defence and the third as active.

The first method raises an old problem which has been the subject of discussion by experts for many years. In the history of artillery, there has been a constant struggle between shell-power and protective armour, and each improvement in armour has brought about a corresponding increase in shell-power which has nullified it. At present, the "blister," or bulge, superimposed on the side of a ship below the waterline is claimed by many to be an efficient protection against torpedo attack. Cases have occurred in which a capital ship has continued fighting after being hit by one 21-inch torpedo, and

returned to harbour safely after many hours at sea. Designers claim that a capital ship should be able to get home after being struck by two such torpedoes, but it may be inferred that the explosions of three would almost certainly be fatal.

As ships are designed to-day, they are certainly vulnerable to attacks with heavy bombs from above. It will be possible, of course, to armour the decks, superstructure, etc., against such an attack, but this innovation would considerably increase the weight of armour to be carried by a ship, and involve loss of efficiency and a further increase in the already extravagant cost of building a capital ship.

In the future there will be continual and progressive competition between the power of the torpedo and the efficacy of nets, "blisters," and other forms of protection below the water-line, and between bomb-power and overhead cover. Improvements in design and the introduction of new defensive devices will push up the weight and power necessary for attack, but will never defeat it.

### Guns *versus* Aeroplanes.

Gunfire is the most effective means of passive defence against aerial attack During the war, anti-aircraft gunfire never *prevented* aerial bombing attack. It drove reconnaissance machines and bombers up to a great height and, no doubt, interfered, to some extent, with the accuracy of their work; but casualties from anti-aircraft gunfire were extraordinarily small. It must be remembered, however, that in 1914 no gun had ever fired at aircraft in the air, and that the whole of the equipment, sights, and ammunition were developed, and the methods of laying and ranging devised, during the war.

It is probable that the accuracy of anti-aircraft gunfire will increase in the same measure as that of bomb-dropping; but the size and power of its shells are strictly limited by the high velocity and great rapidity of fire essential for effective practice. There seems no doubt that, although anti-aircraft fire will usually force the attacker to drop his bombs from a great height, it will never prevent him from reaching his objectives if his leadership and courage are good.

The use of a low-velocity launching tube offers a means of avoiding anti-aircraft fire from guns in the neighbourhood of the objective. This apparatus involves increased weight, and consequent loss of bomb-power, in any given type of aircraft, but its advocates claim greater accuracy than bomb-dropping. Although this means of attack was experimented with during the war, it was never tried out and it may prove a very serious menace to ships, docks, and submarine shelters.

### Defence against Torpedo-carrying Aeroplanes.

So much for anti-aircraft gunfire against attack from a height; a more important problem is to gauge its accuracy against low-flying

torpedo and bomb attacks, and on this head no practical experience has been gained. With the torpedo of to-day, the attack must be delivered from a low height—the lower the better for the accuracy of the torpedo's course. The ships attacked, therefore, can use their ordinary armament and deal with the situation in much the same way as in the case of an attack by destroyers. Aircraft, however, have definite advantages over the destroyer in attack: they are very much faster; they have greater manœuvring power; they need not come down to sea level until the moment at which they intend to launch their torpedoes; and at sea level they are less visible. These qualities lead to the conclusion that, if the ship attacked were not already engaged, the best form of defence would be an intense barrage applied by the whole of the broadside armament, and it has also been suggested that a water barrage could be created by the broadside striking the surface of the sea at some selected range.

Both these methods would be most expensive in heavy shell and in wear and tear of the heavy guns, and both could be circumvented. In an attack by a number of aircraft, a few could be sent ahead to draw the fire; as soon as the barrage of either shell or water was established, it would not be difficult either to fly round it, or to fly over it and side-slip to a height from which torpedoes could be discharged.

It is also probable that it will be possible in the near future to discharge torpedoes with accuracy from a considerably greater height than is the case now.

### Attack by Smoke Bombs.

Another form of attack will be to drop smoke bombs from a height on to the surface of the sea to the windward of the ships previous to the arrival of the torpedo craft. By this method, the ships will be completely blinded for a period, during which the torpedo attack will be delivered. This may prove to be an extravagant method of attack as it may be difficult to direct the torpedoes very accurately, though if a breeze is blowing, the smoke screen would probably be sufficiently low to enable the aircraft to see the mast heads of their targets. In any case, a large fleet steaming in formation offers a very easy mark even for blind shooting; and if the attackers have avoided or brushed aside the opposing fighting aircraft, no other means of defence remains.

Passive defence will undoubtedly be considerably developed in the future. Guns will be increased in number and will gain in accuracy and power; armour will be strengthened; new devices will be adopted. High speed, and the power to manœuvre in the third dimension, however, will always enable aircraft to approach within striking distances of their objective. They will, of course, suffer casualties, but the main power of the attack will not be stopped. The attack having been delivered, the efficacy of armour and design is pitted against the power of bomb, shell, and torpedo, and it seems inevitable that the latter must always be capable of breaking through the former.

### Fighting Aircraft for Defence.

Let us now turn to the active form of defence—fighting aircraft. During the war, this proved to be by far the most effective method of preventing hostile reconnaissance. There were periods both in France and Palestine when the enemy's aircraft practically never ventured over our lines, so much did they fear our fighting scouts. Later on, however, as air tactics progressed, it was found that a well-led and well-trained formation of big, fast bombers could ward off the attacks of the fighting scout, and although it usually suffered some casualties, it could always reach and attack its objective regardless of the efforts of the hostile fighters to prevent it.

Now the tendency is for bombing and torpedo aircraft to grow larger and faster, and to be more powerfully armed. Strength and simplicity in construction, long-range guns, a multiplicity of machine-guns, armour, fire-proof tanks, and duplicated crews, will enable the large aircraft of the immediate future to withstand very heavy fire, both from anti-aircraft guns and from small fighters, before being put out of action. One is therefore forced to the conclusion that fighting aircraft must also increase in size and gun-power if they are to be a serious means of defence against aerial attack. The fighting aircraft with a fleet at sea, however, being carried in and flown from ships and being forced by circumstances to alight thereon when their fuel is expended, or be lost to the battle altogether, must be strictly limited in size and power. The inevitable deduction is that a serious aerial attack by the powerful aircraft of the future Independent Air Force cannot be prevented by even the most efficient means of defence—the fighting aircraft carried by the fleet. What means of defence is left to us? Undoubtedly the provision of powerful fighting aircraft which can meet the big bomber and torpedo-carrier with some superiority in speed and armament. But these will be big aircraft, and too unwieldy to accompany the fleet to sea in carriers. They must, therefore, work from a shore base and have a considerable fuel endurance, which leads to the natural conclusion that their operations will be the affair of the Air Ministry, and that they will work independently, with the sole object of meeting and defeating the hostile air fleets. In fact, the "capital-ship" of the air is almost an accomplished fact, and the future will see a constant struggle for supremacy between aircraft designed to carry destruction to the surface of sea and land, and fighting aircraft whose duty it is to prevent them and clear a way for their own aerial attacks on the enemy's vital spots.

Offence has always been stronger than defence in war; and no campaign has ever yet been brought to a really successful conclusion except by means of offensive action. The inherent strength of offence lies in the fact that all available force can be concentrated at the point selected as being of the greatest decisive importance, whilst the defence must always be comparatively strong at all points.

The third dimension—height—projects this advantage into another plane in which the offensive again has distinct superiority over the defensive for the same reason. In aviation, the attacker can select

the height of his attack, as well as the point of incidence, and this fact gives to the offensive in the air a far greater measure of superiority over the defensive than has been the case on land and sea in the past It seems clear that no possible means of defence will guard a fleet from close and determined attack with bombs and torpedoes from the air.

AVIATION AND THE WORK OF THE NAVY: TWENTY YEARS HENCE.

It is now necessary to try to visualise the effects of aviation on naval warfare as we know it. The Navy to-day has four main duties:—To protect our shores from invasion; to protect our seaborne commerce; to transport our armies in safety to points on or near hostile territory; to destroy the enemy's seaborne commerce. Our Navy succeeded in carrying out all these duties during the Great War, although, at one time, the German submarine very nearly starved us by destroying our merchant ships. It is claimed that if the Germans had put more energy and a greater portion of their resources into the submarine campaign at the beginning of the war, they would have brought us to our knees in spite of our naval supremacy. The German Navy accomplished none of the duties enumerated above, and eventually failed to starve us; consequently Germany was beaten.

Let us imagine a situation similar to that of August, 1914, with the exception that both nations are supported by air power on a scale which could be arrived at twenty years hence, and that Germany has a definite and effective superiority in the air. Could our Navy do anything to prevent devastating attacks from the air on London or any of our big industrial centres? No. Could our command of the sea protect our seaborne commerce? Only when it was out of aerial range of hostile territory. Could our transports cross the Channel in almost perfect safety and with unfailing regularity? No; they would suffer most serious, and perhaps crippling, losses in spite of anything our Navy might do. Could the Navy destroy the enemy's seaborne commerce? This would be possible on account of Germany's geographical position, which is peculiarly susceptible to blockade by Great Britain. So even with command of the sea, our Navy could only perform one of its duties completely and one in part; but it is doubtful whether the command of the sea could long be maintained in such conditions. Our fleets could certainly no longer lie at anchor at Harwich, Rosyth, or Scapa Flow.

Let us be more optimistic and assume that we have a distinct superiority in the air. How far will this alter the position of the Navy? No invasion by Germany would be possible in face of our aerial supremacy. The Air Force would relieve the Navy of a considerable portion of its duties in protecting our seaborne commerce; in any case aircraft are certainly the most dangerous enemies of the submarine. The Air Force would also be a predominating factor in protecting the transport of the Army across the sea. It will be the most efficient means of destroying the enemy's seaborne commerce either from our own shores or from aircraft-carrying commerce destroyers.

This is merely an arbitrary example. Similar problems relating to various other possible adversaries can be considered. In all cases, it will be found that air supremacy is the dominating factor, and that aviation has usurped the functions of the Navy and Army to an extent which varies with the geographical position of the country considered. Thus, it seems inevitable that the offensive power, the supreme importance and the wide scope of the Navy as it exists to-day must be considerably curtailed by the development of aviation. The value of the capital ship becomes problematical. The maintenance of big naval bases on our eastern coasts is a dangerous policy if European war is still to be anticipated. The value of the submarine must be enhanced; it is the only seaborne craft than can hope to defy aerial attack. In fact, aviation has become, par excellence, the weapon of offence. No war can be won except by offensive action; and consequently the Navy and the Army must give way to the new arm in national importance, and in their claims on national expenditure.

### Co-operation between the Services.

Finally, the amphibious nature of aviation will demand a greater measure of close co-operation between the Navy, the Army, and the Air Service than ever before. This can only be obtained by expert executive control in war. Such an organisation cannot be extemporised with efficiency, and so should exist in peace. This leads to the fact that the institution of a Minister for War and a War Staff with control over all three services is a logical development for the future. By such means, the three services can be developed to meet the demands of a really co-ordinated scheme of national defence, and the funds available for armaments can be apportioned according to the importance of the activities of each arm demanded by this scheme. The Power that neglects the Air in order to maintain the strength dictated by preconceived ideas for land and sea, will assuredly lay herself open to attack and defeat.

W. S. Brancker.

## CHAPTER IX.

### The Problem of Empire Defence.

The Great War of 1914–18 has wrought a change in the problem of Empire Defence. The Empire itself has changed, both "at home" and abroad. On land, the defence problem confronting the people of the United Kingdom has been altered by their accepting extended military commitments to police and to defend wide areas of "mandated" ex-Turkish territories in Mesopotamia and Palestine, and ex-German territories in East Africa. The problem of sea defence has been altered by the collapse of German sea-power and the growth of foreign navies in the Pacific. The United Kingdom has become less vulnerable, and other parts of the Empire more vulnerable, as the result of the centre of interest in sea-power having moved from the North Sea to more distant oceans. The defence problem confronting the nations in the Dominions and India has completely changed.

There is no precedent in history for such an "Empire," so we cannot, like the sons of Epimetheus, look backwards for help to find the forward path. It may be that, for the British "Empire" proper, (the United Kingdom and the Colonies, Protectorates, and mandated territories governed therefrom), we might derive warnings from the causes that brought about the fall of other empires in the past, but, loosely grouped with the United Kingdom, sharing few of these extra responsibilities, we now have the "British Commonwealth of Nations"—a group of States, for all practical purposes independent, linked together only by sympathy in ideals and by allegiance to the same constitutional Sovereign.

There came into my hands some years ago, through a second-hand bookseller, a Blue-book bearing the date 1860, entitled "Report of the Commissioners appointed to consider the defences of the United Kingdom." It was signed by three Major-Generals and a Colonel, and, surprising to relate, by a Rear-Admiral and a Captain in the Royal Navy. It put forward, as a guiding principle in sea defence:—

During the wars of the early part of this century, when the strength of the Royal Navy had attained an extraordinary development, it was equal to the performance of all the duties imposed upon it; but it appears doubtful to your Commissioners, having regard to the present state of continental navies, whether even a fleet of such magnitude as we then possessed, would now be able to perform them all efficiently. A much larger proportion would be required for purely defensive purposes than previously, owing to the certainty with which the movements of fleets can be combined with the aid of steam, and the rapidity with which a large force can be concentrated at a given time on any point. Even if it were possible that a fleet sufficient to meet the emergency of a sudden naval combination against this country could be kept available and fully manned in time of peace, such an application of the

resources of the nation would lead to an outlay of the public revenue far exceeding the expenditure which would suffice for that object under other circumstances. The first cost would be very great, and the necessary expense for maintenance would be continual, involving the employment of a large additional number of trained seamen,—a class of men who can with difficulty be obtained, and who are necessarily the most costly of any branch of the military service, owing to the various qualifications required of them. A periodical renewal of the entire fleet would, even under ordinary circumstances, be requisite about every thirty years . . .

And so on. Fortifications were recommended by the Commissioners as a cheap substitute for adequate naval defence—the most pernicious doctrine ever put before a public dependent for existence upon sea communications. Eighteen years later, the European war-scare of 1878 aroused public interest in our defence resources. The "Jingo" song was written, and sung in many music-halls. "We've got the ships, we've got the men," etc., was its refrain. We had neither at the time, and panic soon resulted. On September 12, 1879, another Royal Commission was appointed with Lord Carnarvon as chairman. The Commissioners soon grasped the basic principle of Empire Defence, that everything depends upon the Navy; they defined its functions in war as "blockading the ports of the enemy, destroying his trade, attacking his possessions, dealing with his ships at sea, and preventing an attack in great force against any special place." Although the Carnarvon Commissioners' conclusions wrought a revolution (behind the scenes) at the Admiralty in questions of policy, they were not communicated to the public until five years later, when they were printed amongst the Appendices to the report of the Colonial Conference of 1887 (C. 5091).

### Opinion at the Close of the Nineteenth Century.

In order to recall the mental attitude of our statesmen and of the public towards the naval defence problem in 1887 and in subsequent years, it is worth while to read over the speeches made during that and succeeding Empire conferences up to the outbreak of the Great War. During the earlier conferences, complete confidence was shown by British statesmen in accepting, on behalf of the people of the United Kingdom, the full responsibility for guarding the Empire's communications all over the high seas, while, at the same time, welcoming any assistance which might voluntarily be rendered by the Dominions, who participated by providing only for their own local defence. Wider views began gradually to prevail. Then came the German menace. In 1909, the danger was made evident to all by the secret acceleration of the German naval programme. That led the Government of the day to summon the special Empire Defence Conference of that year, at which the Prime Minister (Mr. Asquith) explained the nature of the emergency, but the Admiralty's brief, containing proposals for dealing with the situation, was not in the hands of members until a few hours before the subject of naval defence was discussed. There was no time for consideration, and the results were disappointing. The impression prevailed that, without help, the people of the United Kingdom, in view of the British agreement with Japan, could still undertake the responsibility for

maintaining the security of the Empire's sea communications in face of any probable menace. In 1912 the Admiralty wrote (to Canada):—

Great Britain will not in any circumstances fail in her duty to the Dominions of the Crown. She has before now successfully made head alone and unaided against the most formidable combinations, and she has not lost her capacity by a wise policy and strenuous exertions to watch over and preserve the vital interests of the Empire. The Admiralty are assured that His Majesty's Government will not hesitate to ask the House of Commons for whatever provision the circumstances of each year may require.

Again, and this is an important exposition of the sea problem:—

Naval supremacy is of two kinds, general and local. General naval supremacy consists in the power to defeat in battle and drive from the seas the strongest hostile navy, or combination of hostile navies, wherever they may be found. Local superiority consists in the power to send in good time to, or maintain in, some distant theatre forces adequate to defeat the enemy or to hold him in check till the main decision has been obtained at the decisive point. It is the general naval supremacy of Great Britain which is the primary safeguard of the security and interest of the Great Dominions.

One more quotation from the same source:—

At the present time (1912), and in the immediate future, Great Britain still has the power, by making special arrangements and mobilising a portion of the reserves, to send, without courting disaster at home (viz. in the North Sea), an effective fleet of battleships and cruisers to unite with the Royal Australian Navy and the British squadrons in China and the Pacific for the defence of British Columbia, Australia, and New Zealand, and these communities are also protected, and the interests safeguarded, by the power and authority of Great Britain so long as her naval strength is unbroken. This power, both specific and general, will be diminished with the growth, not only of the German Navy, but by the simultaneous building by many Powers of great modern ships of war.

Six years later, with the aid of allied sea-powers—France, Italy, Japan, Brazil, and ultimately the United States,—we emerged from a four-years' struggle against the sea-forces of Germany, Austria, and Turkey with our "naval strength unbroken." The enemy's principal naval bases in the Great War were in the Baltic, North Sea, and Mediterranean. What, it may be asked, will be the problem of the future, and of what value to the British Empire, if any, is experience, so gained, in solving that problem?

## Admiralty Memorandum on Sea Power.

In 1902, before the German menace arose, the Admiralty, in a memorandum on Sea Power, told the Dominions that the requirements of naval strategy necessitated our being strong enough to conduct a vigorous naval offensive all over the world, while, at the same time, concentrating a sufficient force to ensure victory, in the decisive battles, in whatever part of the seas those battles might take place. By 1912, the Admiralty, as we have seen, had altered their view of the necessary requirements of British Naval strategy, and spoke no longer of a simultaneous vigorous offensive, but of "holding the enemy in check (in distant theatres) till the main decision has been obtained at the decisive point." In the late war, the Battle of Jutland occurred nearly two years after, and the surrender of the German Fleet four and a half years after, the outbreak of

hostilities. Bearing that point in mind, it will be well for us to revert to the changes wrought by those years of war in the Empire itself, before we discuss further the problem of Empire Defence.

In the "Empire" proper, the territories and population governed from the United Kingdom, the main problems of defence remain as in pre-war days, excepting that territorial responsibilities have been extended, and vulnerability has been increased, by the acceptance of mandates in Mesopotamia, Palestine, and East Africa. On the finance side, the cost of the air service, the enormous increase in the Civil Service estimates, the long-deferred grant of higher pay to the Army, and the heavy charges for war pensions and interest on debt have reduced the resources of the taxpayer in the United Kingdom to make adequate provision for sea security.

In the Commonwealth of self-governing nations, as distinguished from the "Empire," we notice a great change. Their strong sense of nationality, as well as resentment of all outside control, has been developed beyond all pre-war estimates by the part that they have taken and the sacrifices they have made in a great war against European Powers. As already noted, they are now, for all practical purposes, independent States, grouped together, it is true, under the same constitutional Sovereign, but without any central constitutional government for the whole. Only two official links remain. There is one final court of appeal for all, the Judicial Committee of the Privy Council, and the channel for official communication with foreign Governments, in matters affecting peace or war, still runs through the Foreign Office in London. It is still recognised as desirable, in addressing foreign Governments, for the Empire to speak with one voice, and that this can only be done by speaking through one mouth. These official bonds are being loosened year by year. In legal matters, appeals beyond the local High Courts of Justice are now almost unknown in some Dominions; in foreign affairs the status of independent states was, to all intents and purposes, conceded by the Allied and Associated Powers when the signatures of representatives of the Dominions were appended independently to the Peace Treaties. It is true that ratification was withheld by the United States, but it seems (on paper) but a short step to the "optional neutrality" of the Dominions in wars in which the United Kingdom is involved, which would lead logically to the optional neutrality of the United Kingdom if a Dominion were attacked. Neutrality in war means the internment of belligerent troops and the denial of the free use of harbours to belligerents.

Such are the political problems, seriously affecting Empire Defence, that now confront the statesmen of the Empire and Commonwealth. The Imperial Conference of 1917 passed a resolution in favour of their being studied by a special conference on constitutional questions, to be held after the war. Defence, and other matters bearing thereon, have been discussed by the Prime Ministers and representatives of India, during the past summer.

Reading between the lines of the official report on their discussions, it is clear that the proposal to hold a special constitutional conference is not, at present, likely to materialise. Emphasis is

placed upon the need for continuous consultation, and upon improvement in communications in order to facilitate annual meetings of the Premiers. The King, in his reply to their loyal address, laid still stronger emphasis on this point in the words :—

> Every facility should be given for such periodical meetings, and to ensure this we look confidently to the men of science and research to discover improved means of inter-communication between all parts of the British Commonwealth.

Co-operation depending upon better communications, the future is in the lap of the gods. The present is our own, to do with what we will, and the first and most important step in solving the problem of Empire Defence is to establish a standard of sea security. Such standards are sometimes based upon what has to be defended. They should mainly be based upon the strength and geographical distribution of foreign navies. At one time, when European Powers held the lead in modern fleets, we had a "Two-Power standard, regardless of flag." We assumed that the friend of the day might become the enemy of the morrow, and our interests in sea security were considered too vital for us to gamble upon the goodwill of any Power. All were classed as prospectively hostile. We began to abandon that standard, as too expensive, when Russia increased the number of her capital ships in the China seas, and a policy of alliances and of understandings began to take the place of "splendid isolation." We then contracted an agreement with Japan, which enabled us to concentrate our sea-forces to face Germany. In 1912, we altered our standard to one of sixty per cent. in capital ships above Germany, the sea-power next in strength to ourselves, and notoriously hostile.

### The One-Power Standard.

We have now (1921) adopted a One-Power standard; America, as the next in strength, is the Power indicated. In both countries, the point has been, and will again be, raised that such a standard is unreasonable because neither nation can be classed as prospectively hostile to the other. Obviously we must have a standard of some sort; we cannot build a policy upon no foundations at all, and it is only fair that critics of the One-Power formula should be asked to put forward a better one. It has been suggested that we should go back to the principles which obtained before the German menace arose, and that we should revert to the "Two-Power standard, regardless of flag," which did so much to keep the peace of Europe as long as we were prepared to face the expenditure, but that the Navy of the United States should *not* be taken into account in our calculations. Mr. Asquith, in the debate on the last estimates, put forward as a formula: "a Navy . . . adequate to secure the safety of our sea-girt empire and our sea-borne supplies against any reasonable, calculable risk." Lord Grey of Fallodon, at a League of Nations dinner to the Prime Ministers, deprecated competition with the United States, and suggested a standard based on the strength of European fleets. These standards seem well worth considering and comparing with the "One-Power" standard,—and that Power the

United States,—which has been adopted provisionally. They do not indicate individual competitors and arouse national rivalry and mad competitions in armaments, and they enable the seamen at the Admiralty, (the sole qualified judges, on the technical side, of the number and nature of vessels required to meet the necessary conditions), to take the geographical situation of prospectively hostile Powers into consideration in coming to their conclusions.

Any standard which is based upon the strength of foreign navies, automatically takes note of the world movement for reduction of armaments, voiced by the League of Nations assembly, and, independently thereof, by statesmen and public opinion in the United States. The movement is taking practical shape in the Conference to which President Harding has invited the Powers concerned, especially those affected by the situation in the Pacific. No further reference need be made to that subject in this article, because reductions, if proportional, would not effect relative strength at sea. Their effect would only be to curtail, in proportion, the cost to each nation concerned.

In our search for a standard, the importance of the geographical distribution of prospective rivals in sea command has been impressed because of its bearing upon the technical side; it affects the nature of the vessels to be provided. Apart from territorial security, the chief object in view is to secure safe passage for our own merchant ships and troop traffic, while rendering an enemy's insecure. In different parts of the world, the greatest danger might come from different sources, from surface vessels in some seas, from submarines in others, from aircraft, perhaps, in others.

## Defence and Finance.

Our standard of naval defence must be affected by our resources. In view of foreign competition, it is clear to the whole world that the people of the United Kingdom, unaided, cannot provide for the "requirements of naval strategy" in every sea as defined in the Admiralty Memorandum of 1902. The ideal which used to be advocated by the Admiralty on the score of effectiveness and of economy, was that the whole Empire and Commonwealth should share in providing both the men and the money required to maintain a single Navy, under one single authority in time of war, and distributed, in time of Peace, in accordance with strategical requirements, rather than with local desires. Owing to the growing sense of nationality, to which reference has already been made, this ideal has proved impossible of attainment. Political influences have overridden purely naval considerations. The policy of local navies has been accepted. The Naval Staff at the Admiralty is following the example of the General Staff at the War Office in its efforts to ensure in the sea forces the uniformity in staff work, organisation, material, and training which contributed to the success of the Empire's land forces in the late war. These matters are *sub judice*, pending a decision by the several Parliaments concerned, and further discussion of this aspect of the problem would not therefore be

beneficial. The resolution passed by the Premiers last summer ran as follows:—

That, while recognising the necessity of co-operation among the various portions of the Empire to provide such Naval defence as may prove to be essential for security, and while holding that equality with the naval strength of any other Power is a minimum standard for that purpose, this Conference is of opinion that the method and expense of such co-operation are matters for the final determination of the several Parliaments concerned, and that any recommendations thereon should be deferred until after the coming Conference on Disarmament.

A note was added to the effect that representatives of the several Dominions and India discussed with the Admiralty such subjects as the loyal co-operation of each Dominion "in regard to the provision of oil-tanks, local naval defence, etc." It will be as well, while recognising the need for local naval defence, to emphasise in this connection the point, so well put by the Carnarvon Commissioners forty years ago, that the naval defence essential for the security of the British Empire must provide for the safety of merchant shipping and transports at sea, and not only in local waters.

The German menace drew the whole British Commonwealth of nations and Empire together, and that menace has now been removed. It raised a clear issue, understood by all, and all were willing to submit to sacrifice in the defence of certain principles in international relationship and in national government. Our pre-war defence policy was designed to meet a clearly defined menace. In place of a world of nations in arms, with their armaments organised to the last detail in readiness to work on a hair trigger, we now look round on a world exhausted by warfare, weary of it, and anxious to lessen its probability by establishing a League or Association of Nations, destined, it is hoped (in M. Viviani's words), to become "not the super-Government, not the super-Parliament, but simply the moral arbiter of the world."

There should, in the present condition of the world, be time for thinking matters over, and for discussing the problem of Empire Defence before a new menace arises to the freedom of the peoples grouped under the White Ensign and the Union Jack. An endeavour has been made in this article to set forth some of the most important aspects of the problem. Whatever machinery may be established, and whatever conclusions may be arrived at, it will be necessary to build them upon definite and generally accepted principles. These, as set forth in pre-war days by the Imperial General Staff, are three in number. They may be summed up as (1) Security of sea communication, (2) Local provision for local defence, and (3) Mutual support where local resources do not suffice for the purpose. The new conditions introduced into the problem since pre-war days are the removal of the German menace, the extension of military responsibilities on land by accepting mandates for wide areas of vulnerable territory, especially in the middle East, the heavy burdens falling upon the British tax-payer, the strengthened spirit of independent nationality developed in the peoples of the British Commonwealth of nations by their war effort and participation in foreign

affairs, the introduction of the submarine, the extended use of the submarine mine in sea warfare, the development of aircraft, and the growth of foreign navies in the Pacific. In these days, as in our past history, the most urgent requirement in Empire Defence is the establishment of an adequate standard of sea-power.

GEORGE ASTON.

# CHAPTER X.

## Auxiliary Machinery of Ships.

Although the design of the main propelling machinery for large or important ships always receives very careful consideration, and properly so, it sometimes happens that much less attention is given to the auxiliary machinery of these vessels, and many benefits that might accrue are thereby lost. This is due to the concentration of the thoughts of the machinery designer on the arrangement and details of the main engines and boilers, provision being made only for space for the accommodation of the auxiliary machinery. When it is realised, however, that the engine and boiler-room auxiliaries are simply detached portions of the propelling machinery itself, and that, while necessary and important in themselves, they exercise a very large influence on the performance of the main propelling machinery, it will readily be conceded that auxiliary engines deserve the best and fullest consideration that can be given them at the design stage of the propelling machinery, in order that they may be incorporated with the essential features of the complete design, and ensure the best all-round result.

Simultaneously with the advances made in recent years in propelling machinery and boilers, which have been reviewed in previous issues of the "Annual," valuable progress has been made in the various types of auxiliary engines, and the appropriate utilisation of these improvements cannot fail to be of great advantage in all classes of ships. Among the large body of British scientific engineers engaged on marine work are many auxiliary-engine manufacturers who keep themselves fully in touch with the trend and progress of marine engineering, who are constantly experimenting and making improvements to keep themselves ready to meet the most modern demands, and who maintain the reputation of their manufactures by the highest class of workmanship. These manufacturers stand in a class by themselves: a class of a very high order, approached only by few and excelled by none.

High-class auxiliary machinery always has been and is still available for use both in warships and merchant vessels, but it can be utilised to the greatest advantage only if the talent and experience of auxiliary-engine makers are brought to bear upon the problem of properly incorporating the auxiliary machinery into the general design at a very early stage. For not only is the auxiliary engine of importance in itself, but the maker may be able to indicate how it might be rendered even more valuable by modification of minor fittings, which probably he could best suggest, by a more suitable arrangement in the ship in relation to other machinery or

fittings, or by modification of ship or machinery fittings which are altogether outside the scope of his supply.

For example, one of our foremost auxiliary-engine makers has carried out a very extensive series of experiments, lasting over many years, on fans, fan engines, and the conditions affecting satisfactory supply of air to, and the discharge of gases from, boiler-rooms. The experimental data thus obtained not only enables the maker to design to the best advantage the machinery he has to manufacture and supply, but it justifies him in giving advice in such matters as the position of the fans in the ship, the fittings necessary for proper air distribution in the boiler-room, and the suitability of the air-supply arrangements. This is merely given as an example; most other makers have similar particulars available, which would enable the best to be obtained from the engines they manufacture. It is in the utilisation of the experience, often gained from long experimental work, of auxiliary-engine makers in the early stages when machinery installations are in course of conception, that auxiliary machinery will take its real and proper place in the march of progress of marine machinery.

## The Attributes of Good Auxiliary Machinery.

Auxiliary engines naturally divide themselves very readily into two classes: those which are essential for the working of the propelling machinery and which are really a detached part of that machinery, and those which are used for the general work of the ship, *i.e.* other than for propulsive purposes. There is nearly always some overlapping, engines being frequently made suitable for other than their primary purpose, but the diversions are generally of minor character only and the division is well understood. In either division, the same attributes are required of the auxiliary engines, viz. reliability, economy of working, cheapness in first cost, and durability; and probably they are given in order of importance in general opinion. They are the same qualities as those required in propelling machinery, which goes to prove the relative importance of auxiliary machinery, indeed, in some respects such as reliability, the degree of quality required in some auxiliary engines is superior, if anything, to that looked for in the main machinery.

The first named, and the most important, requirement, reliability, has fortunately been realised to a very satisfactory extent in recent years. This view will be endorsed by those marine engineers who had experience at sea with the old type crank feed pump working with heavy load against high boiler pressure, and with the modern type crankless pumps working perfectly without giving cause for any anxiety whatever. The crankless pump has been very extensively adopted for auxiliary purposes connected with propelling machinery, and its reputation for reliability has been well maintained, but it has the serious drawback that it is very expensive in steam consumption. Its continued general adoption for pumping purposes, in spite of this drawback, proves that reliability is the chief requirement in an auxiliary engine.

Another factor which has played an important part in placing auxiliary engines in their present satisfactory position as regards reliability, is the adoption of forced lubrication, especially for high-speed reciprocating engines such as fan engines. In the Navy, a serious breakdown of an engine fitted with forced lubrication is now a very rare occurrence; previously such breakdowns were unfortunately too frequent. Forced lubrication has been of immense value to auxiliary machinery as well as to main machinery.

## Economical Working.

Economy of working is placed second in order of the attributes of good auxiliary machinery, but it has received more thought than any of the others, because it is more difficult of attainment, and with all the improvements that have been made in recent years, a great deal is left which is desired, and is felt to be within the bounds of possibility, although the way to success is not yet clear. That the subject is one of importance is evident from the facts that, in our modern capital warships, the average consumption of fuel at sea for all auxiliary purposes approximates to one-sixth that for the main engines, while at certain speeds the ratio is still higher, and that the daily expenditure of fuel in harbour, *i.e.* for auxiliary purposes quite separate from the propelling machinery, averages, in a few cases taken at random, about 15 tons of oil in a capital ship and 8 tons in the light cruiser class.

Small auxiliary steam engines of all types are expensive in steam consumption, and although much has been done to improve them in this respect and much has been and can still be done to prevent avoidable radiation losses by more suitable pipe leads and by lagging (and a small outlay for better pipe covering in the first place would in many cases soon be repaid), yet much still remains to be accomplished. It is feared that, to a great extent, this reproach of the small steam engine is inherent, and that it will always deserve its reputation of being a great steam eater. For many other reasons, however, steam auxiliary engines are preferred by most users for a great variety of purposes on board ship, and the manufacturers have been put upon their mettle to endeavour to make them more economical.

## Turbine-driven Auxiliaries.

The success which attended the introduction of the steam turbine naturally induced auxiliary-engine makers to investigate its possibilities for their respective shares of the general installation, and many very interesting and useful developments were made. Certainly nothing was lost in reliability and durability when using steam turbines for auxiliary purposes, but unless a considerable first outlay was incurred, improvement in economical working very rarely resulted.

An important factor in the economical working of a steam turbine is that the final absolute pressure of the steam leaving the turbine

shall be very low. This is difficult to arrange for in small turbines where weight and space are limited, but, even if the design can be satisfactorily arranged, it is more difficult to ensure satisfactory external conditions on board ship. Most auxiliary engines exhaust into a common exhaust pipe of considerable length and limited diameter and of tortuous course, resulting in much higher final pressure at the turbine than is necessary for economy. In the Navy, for reasons that are well known, but which are not governed by consideration of the auxiliary machinery, the exhaust is "closed," and a pressure of 25 lbs. per square inch (gauge) is maintained. This tells terribly against economical working of auxiliary steam turbines, and, as a matter of fact, economical results have only been obtained in the Navy when the turbine is provided with its own condenser, with very short and separate exhaust pipes of large area, and separate circulating and air-pumps. So far, such installations have been adopted only for electric-generating machinery for the ship's general service. They have performed satisfactorily, and have been quite reliable, but their first cost has been comparatively high.

### The Problems due to Superheated Steam.

It may be that the general trend of marine engineering will force matters considerably in the near future. It has previously been stated that auxiliary machinery plays an important part in the functioning and performance of the main engines. These actions are reciprocative: the development of the main engine compels consideration of new types of auxiliary engines. Economical performance has been, next to reliability, the paramount factor in deciding both, equally in the Naval and the Mercantile Services. The problem has been the more difficult in the former service, as, while it is desirable to provide as far as possible for cruising speeds, at which the greater part of the steaming is done, satisfactory performance at full power and at high speeds is necessary; and the two are not compatible. This will be recognised when it is realised that the power required to give the cruising speed in modern warships is, put roughly, only about one-tenth the full power, and in certain cases or under certain conditions it may be even lower. In both services, superheated steam for the main engines is considered to be an essential condition. It has been extensively and satisfactorily adopted in the Mercantile Marine, and, to some extent, in the Navy, for high-power working, but so far it has been found impracticable to gain the advantage in naval ships steaming at cruising speeds, at which it is most desired, as about 80 per cent. of the work of our warships is done at cruising speeds, because, at the low duty of the boilers at these speeds, superheat of the steam with existing fittings has been found to be impossible. Experiments have been going on for the last year or two, and superheaters have now been evolved which it is confidently expected will enable a fairly high degree of superheat to be utilised in the main engines at all powers from full power down to the power required at cruising speeds.

With this development comes the problem of the auxiliary

engines. To put it broadly, reciprocating engines do not give their best with highly superheated steam. Some economy in working may result in the early stages, but it is not maintained owing to wear in the cylinders and piston rings. Graphite and other lubricants have been brought into service which have had the effect of minimising the evils, it is true, but have not sufficiently overcome them. It appears probable, therefore, that turbine-driven auxiliaries will have to be used with superheated-steam installations more extensively than in the past, and it will be the duty of the auxiliary-engine makers to give a very great deal of attention to their design to ensure better economical performance, both at high and at low powers, than they at present exhibit.

## Applications of Turbine-driven Auxiliaries.

As very interesting examples of the endeavours to use turbines for auxiliary purposes connected with the main propelling machinery, several may be reviewed.

Turbine feed-pumps have been successfully used in shore generating stations for many years, and with unlimited space available, and with ample means and notice for varying loads, they have given very little difficulty in operation and a large measure of satisfaction. A trial of these pumps as main feed-pumps has been made in H.M.S. Birmingham and, for several years, including the whole period of the war, the test has been quite satisfactory, but the auxiliary reciprocating pumps have had to be depended upon a great deal when manœuvring or when entering and leaving harbour. It is understood that the experience has been similar in the Merchant Service. The problem of utilising such pumps is very difficult when the boiler-rooms are much subdivided as in large warships, but the subject is by no means dead and it will receive a large measure of consideration in the future.

The large, high-powered propelling installations fitted in some of our capital ships compelled the use of very large engines for driving the centrifugal circulating pumps, necessarily at high speed, and the loads due to inertia of the reciprocating parts became very high. Economy was obtained, in some cases, by the use of compound engines, but the load troubles remained. As with propelling machinery, attention turned to the turbine and an installation was fitted in H.M.S. Queen Elizabeth. Again this installation has proved quite reliable over several years, but it is feared that it is not economical at low powers. Similar installations have been made in several destroyers with the same record of performance.

It is well known, that for some years past, it has been the established practice to evacuate the products of condensation, or rather partial condensation, from the condenser in two parts, one dealing with the fully condensed steam or water, and the other with the residual air and uncondensed water vapour. Until a few years ago this was accomplished by separate reciprocating pumps and indeed most ships are at present fitted in this manner. The air-pump portion was

always the more delicate of the two, so that several attempts at improvements were made, and it is now generally accepted that the best means of evacuating the condenser of vapour, *i.e.* of producing the vacuum, is by means of steam jets or ejectors, leaving the pumps to clear them of water. For the latter purpose, turbine pumps have been used without giving rise to any appreciable difficulty.

## "Closed" Feed-Water System.

In this connection, reference may appropriately be made to the combination of another effort with that just referred to. It has, for a very long time, been noticed that corrosion of boiler plates and fittings occurred at the feed inlets to the boilers, and this was generally attributed to the liberation of air in a nascent state and active condition just as the temperature of the feed water is raised on entering the boiler. Many attempts have been made to remedy this state of affairs by heating the feed-water or by special feed heaters, and results have been more or less beneficial. The heating, however, was almost always made on the suction side of the feed-pumps, the feed water being exposed to the atmosphere and therefore at atmospheric pressure, and although air was undoubtedly expelled, the conditions generally did not provide for a large measure of expulsion and often permitted the re-entry of considerable quantities of air. Further, the degree of feed heating was limited on account of vapour interference with the suction of the feed-pumps.

Messrs. Weir, of Cathcart, who have collaborated with the Admiralty for many years on this difficult matter, have evolved a system for combining the evacuation of the condenser with heating of the feed-water and expulsion of air, using a turbine-driven pump for clearing water from the condenser. It is a closed system, preventing the admission of fresh air and expelling any residual air or vapour, providing also for satisfactory supply of hot feed-water to the feed-pumps, without risk of water vapour interfering with the proper duty of the pumps. This system, known as the Weir closed-circuit feed system, has been tried under varied service conditions and has been under close observation in five destroyers, with satisfactory results as a working arrangement at all powers. It is early yet to state whether corrosion at the feed inlets has been prevented, or largely reduced, but the reports received so far are encouraging. It is understood that a similar installation in the s.s. Cameronia has also been satisfactory.

The principles underlying this system are far-reaching in effects, are capable of extensive application in many directions, and are deserving of consideration for many purposes other than that for which they were originally designed.

## Fan Engines.

In certain classes of warships, great difficulty has been experienced in suitably accommodating the fans and engines for a large air supply to the boiler-rooms, and in providing satisfactorily for the many other

essential fittings. To improve matters in this respect, with the expectation also that better economy in steam consumption would be gained, the lead given in propelling machinery has been followed and turbine-geared fan engines have been fitted. The anticipated better conditions of working have been realised, and although no opportunity has occurred for taking direct measurements of the difference in fuel expenditure, there is reason to believe that satisfactory results in this direction have been obtained.

### Electrically-driven Auxiliaries.

Important as the applications of the steam turbine have been, they leave the impression that something more than has been accomplished in economical working is desirable. Greater economy could probably be obtained by employing electric motors for the auxiliary requirements of propelling machinery, but electrical apparatus hitherto produced does not seem to be quite suited to the atmosphere of the engine and boiler-rooms, and simple, light, and cheap methods of control, to suit variable conditions of speed, have not yet come into prominence. These problems hardly seem to be insurmountable and the co-operation of electrical engineers with their marine brethren would be much welcomed, especially when it is recalled that submersible electric motors and pumps, working quite satisfactorily when quite submerged, have been developed and are in common use.

As somewhat against this view there must, however, be set the fact that many marine engineers are loth to accept any intermediary agent for working auxiliary machinery should the failure of that agent result in disablement of the main machinery. This is a practical factor of prime importance, and before electrically-driven auxiliaries can be generally accepted marine engineers will have to be, and to feel, assured that not only such auxiliaries themselves, but also the generating plant, leads and accessories are no more liable to risk of breakdown either in normal circumstances or in emergencies, or from internal or external causes, than the present less economical steam auxiliaries.

### Internal-Combustion Engine Auxiliaries.

In some respects there may also be a field for the inventive genius of the oil engineer. Already our capital ships are fitted with Diesel electric generators for general purposes and destroyer leaders are fitted with paraffin engines for generating electricity for use in harbour for lighting purposes, but applications of the oil engine ought not to be left at that stage.

### First Cost and Durability.

Very little remains to be said on this heading after what has been said in the previous paragraphs. In respect of first cost, the reciprocating steam engine holds the palm, and other engines or motors can

only replace it by offering and ensuring advantages in other respects of a dominating order. Given a sufficient demand, standardisation of tried and reliable machinery will keep down the cost of manufacture, and it can safely be left to auxiliary-engine makers, and to the irresistible demands of scientific engineering to ensure that the one great drawback of standardisation, viz. stagnation of progress, will be prevented.

In point of durability, which includes that of running repairs, there is very little to choose. Most of the auxiliary engines now fitted last the lifetime of the ship without very extensive renewals or repairs. The greatest attention is required with reciprocating engines, but even this is reduced considerably when forced lubrication is fitted. Cylinder and piston-ring wear are considerable and should never be allowed to get the upper hand, as leaks past the piston will react most forcibly on the steam consumption, leading rapidly to extensive waste of fuel. The stitch in time, in this connection, saves many nines.

## Auxiliary Engines for General Purposes.

Small steam engines placed in the ship, with long ranges of steam and exhaust pipes, are comparatively very wasteful in fuel, and, for the general purposes of the ship, the considerations which obtain very forcibly for the propelling machinery auxiliaries do not generally apply. Electric motor driving, with current supplied from a central source, is much more economical, though generally more expensive in first cost. For most purposes, the application of motors is simple, running costs are low and their durability is satisfactory. In some cases, such as boat hoists, capstans, and steering engines, there has been hesitation to accept them, as they have not proved themselves entirely suitable for varying loads.

Improvement has, however, been effected by interposing hydraulic mechanism between the electric motor and the work, permitting the former to run at its natural constant speed, the variation in effort being regulated by the intermediate mechanism, and the results have been very promising. This system has given great satisfaction on shore and for light loads afloat, and important extension on board ship and elsewhere may confidently be looked for in the future.

The heavy oil engine does not, at present, appear to have made much headway for general purposes afloat. Except for driving electric generators, air compressors, and for cargo winches, it has had scarcely any application; surely there are other uses for this cheap working motor.

## Auxiliaries of Oil-Engine Ships.

The auxiliary engines of the oil-engine-driven ship call for some comment. It was quite common when oil engines had been decided upon as the propelling machinery for a ship to desire to dispense with steam boilers altogether. It was thought that the fitting of such boilers for auxiliary purposes would be retrograde, and an

admission that the oil engine could not perform all that was claimed for it. Both in the Navy and in the Mercantile Marine, endeavours were made to this end. In both services, auxiliary machinery driven by compressed air and by electricity were tried, the air compressor and the electric generators being driven by auxiliary oil engines. The experience with the former was generally unsatisfactory, both in point of economy and of reliability, while the latter was generally too high in first cost. With oil propelling engines, steam auxiliaries are now commonly fitted, the saving of face being based on the fact that an auxiliary boiler is required for heating certain kinds of commercial oil to make it pumpable, under extreme conditions of atmospheric or sea temperature, for supply to the ready-use tanks of the main engines.

Sentimental reasons of this kind should never hold sway while main engines are more or less experimental. It should be remembered that the Chief Engineer and his staff have their hands full with the main work, and it will help them and help the development of the system if they are not encumbered at the same time with anxieties respecting the auxiliary machinery in their charge.

When schemes for electrical transmission with propelling machinery are in contemplation, it would probably be advantageous for the main purpose in view to adopt the same attitude, *i.e.* to give all attention in the design to this main purpose, and to enable the working staff to give their undivided attention to it, arranging for the auxiliary machinery to be of more simple and more fully tried and reliable types, leaving their development to a later stage. Success is more likely to be obtained by concentrating, in the first place, on the principal object, instead of endeavouring to solve the whole problem at once.

With a steam-driven electrical installation for auxiliary purposes, however, Diesel sets can be associated with economy and with great advantage for emergency purposes. The capital ships of the Navy are all provided with Diesel engines for dynamo driving in harbour, permitting steam to be let down, with considerable saving of fuel; and many passenger vessels are fitted with emergency Diesel sets for lighting in case of collision or other accident, appreciably assisting the work of the ship, especially at night time, should the boilers and the steam-generating machinery be disabled. The high temperature at which the products of combustion are exhausted from oil engines has been put to good purpose in the Navy and elsewhere, by utilising the heat of the exhaust gas for evaporating sea water, and condensing the steam so gained into water for drinking and other uses.

Much more could be written respecting this fascinating subject of auxiliary machinery, but enough has been said to emphasise its own importance, its influence on the main machinery, and on the internal economy of the ship. It has made great strides in the past; much more will be required in the future, and the best will be accomplished by earlier and more intimate collaboration between the designers of the ship and main machinery and the expert auxiliary-engine manufacturers.

G. G. Goodwin.

## CHAPTER XI.

### The Electric Drive for Ships.

Shipbuilders and engineers in this country appear to have reached the conclusion that, in its present state of development, the disadvantages of the electric drive outweigh its advantages. For instance, Messrs. Parsons are builders both of marine equipments and large electrical power units, and the introduction of electric drive installations would therefore be merely an extension of their present business. The fact that they have not so far produced such a drive is an indication that they do not consider its advantages sufficiently great to warrant the departure.

The General Electric Company of New York, on the other hand, who have already built electric-generating sets of all sizes for use on shore, have also devoted a great deal of attention to the development of electrical propulsion for marine purposes. The first electric propulsion, other than that of small launches, was applied by this company in 1908 to two fireboats for the city of Chicago. They were equipped with generators driven by steam turbines, which also drove directly the centrifugal fire pumps, and with electric motors mounted directly on the propeller shafts. The next step was made when the 7,000 h.p. twin-screw collier Jupiter was furnished with electrical-propelling machinery. This equipment was adopted as a trial of the system. At the same time a geared-turbine equipment for the sister ship Neptune was built by the Westinghouse Company. Even though the requirements of this type of craft do not call forth the particular characteristics of the electric drive, the success of this installation led the Navy Department to adopt electrical propulsion as the standard method for capital ships.

Commander S. M. Robinson of the United States Navy has compared the fuel consumption of the electrically-propelled battleship New Mexico with that of the Pennsylvania, a turbine-driven battleship of comparable displacement and speed, which is fitted with direct-connected turbines and small geared cruising turbines running at speeds up to slightly over 15 knots:—

The trial results of the two vessels show that in total fuel consumption the New Mexico saves more than 20 per cent. over the Pennsylvania at speeds from 19 knots to full power. At a speed of about 15 knots, which is about the limit of the geared cruising turbine, and also of the low-speed connection of the electric drive, there is a very much greater saving, it being something in the neighbourhood of 30 per cent. At 10 knots, the fuel saving is apparently very small, although at both 10 and 15 knots the trial results were not directly comparable on account of the different conditions under which the trials of the two ships were run. Ships fitted with small geared cruising turbines, however, showed remarkably good economy at very low speeds of the ship, such as 10 knots.

And again, after two years' service with this ship, he reports :—

At a speed of 10 knots, the New Mexico uses about 16·7 per cent. less oil than her sister ships, or, putting it another way, her sister ships use about 20 per cent. more than the New Mexico; at 13 knots the figures are 29·9 per cent. or 42·7 per cent.; at 16 knots the figures are 32·3 per cent. or 47·8 per cent.; at 19 knots the figures are 28·6 per cent. or 40·1 per cent.; at full power the figures are 24·4 per cent. or 32·2 per cent. At 19 knots, also at full power, the New Mexico uses about 0·975 lb. of oil per shaft horse-power per hour, and at 15 knots she only uses 1·1 lb. of oil per shaft horse-power per hour. This is a remarkably uniform economy.

In regard to the reliability of the machinery, the New Mexico has had nothing but the most minor troubles with her electric plant, and there have been no Navy Yard repairs whatever.*

The United States battleship Tennessee, which underwent her trials last autumn, is, however, the most interesting ship afloat from the point of view of the electric drive. The New Mexico was originally designed for geared-turbine drive, but this was changed while under construction. In the Tennessee, on the other hand, the design was based upon the adoption of the electric method of propulsion, and full advantage was taken of the opportunity which that system of drive offers for subdivision. She is fitted with two 15,000 k.v.a. Westinghouse turbo-generators, and four 8,000 h.p. Westinghouse propeller motors; each turbo-generator and its auxiliaries, each outboard motor, the two inboard motors, and the control station all have separate compartments, and each of these compartments is as watertight as it is possible to make it, for no provision has been made for intercommunication between compartments without ascending to the level of the gun-deck. There are thus no bulkhead doors which can be left open, or weak spots in the bulkheads which can be burst open by water pressure.

### Progress in the United States.

As an indication of the popularity of the electric drive in America, the following figures published by the General Electric Company in February, 1921, giving the aggregate horse-powers built or building by that Company, are of considerable interest.

| | H.P. | | H.P. |
|---|---|---|---|
| For the Navy: | | | |
| 1 collier . . . . . . | 7,160 | = | 7,160 |
| 4 battleships, each . . | 32,000 | = | 128,000 |
| 2 battleships, each. . . | 60,000 | = | 120,000 |
| 4 battle cruisers, each . | 180,000 | = | 720,000 |
| Total . . . . . . . . | | | 975,160 |
| For the Merchant Marine: | | | |
| 12 freighters . . . . | 3,000 | = | 36,000 |
| 4 coastguard cutters . | 2,600 | = | 10,400 |
| 1 fruit steamer . . . | 3,000 | = | 3,000 |
| 1 express passenger vessel | 3,000 | = | 3,000 |
| Total . . . . . . . . | | | 52,400 |

This table includes the collier Jupiter and the battleship New Mexico, but not the Diesel-electric ship Fordonian, referred to later.

* The comparison between the New Mexico and a contemporaneous all-geared design would not have shown such a decided superiority as was exhibited by the contrast between that ship and the Pennsylvania.—The Editors.

In addition, the Westinghouse Electric and Manufacturing Company of Pittsburg are under contract to build the electric-propulsion equipments of eight more battleships and battle cruisers for the United States Navy, in addition to the battleship Tennessee. Moreover the electric drive has been adopted as the standard method of propelling the capital ships of the United States Navy.

The Japanese, too, are beginning to experiment in this direction, and have just placed a contract with the New York Shipbuilding Corporation for a 20,000 ton Navy fuel-supply ship. This vessel will be 496 feet long with twin screws electrically driven. She will carry both coal and oil, and will be fitted with an anti-torpedo boat battery.

As will be seen later, one of the main advantages of the electric drive is the great efficiency that can be maintained at all powers, and it is this property which makes the system particularly suitable for men-of-war. The Americans, however, have not confined their attention to this type of vessel, and are applying the electric drive to passenger ships and cargo vessels. The Eclipse, an 11,800 deadweight-ton cargo carrier, was fitted with the electric drive during 1920, and, as a result of the experience gained, the U.S. Shipping Board have decided to equip ten similar vessels for electric propulsion. The plant of the Eclipse consists of a single turbo-generator set, supplying power for a single propulsion motor. As an installation of this type loses of necessity many of the advantages which can be obtained from more complex forms of the electric drive, it shows clearly the esteem with which Americans regard this method of propulsion.

The Cuba, a 17-knot passenger boat of 3,580 tons, is a further example of transference to the electric drive. The installation in this vessel consists of a Curtis turbine driving a three-phase 2,350 k.v.a. 3,000 r.p.m. generator, supplying power to a 3,000 h.p., 100 r.p.m. motor. The principal novelty of this installation is that a synchronous motor is employed instead of the more usual induction type. It is stated that, on the official trial of this boat, the propeller was brought from full speed ahead to dead stop in 2½ seconds, and to full speed astern in 7½ seconds more.

## Diesel Engine as Prime Mover.

The Americans are also adapting the electric drive for use with the Diesel engine as a prime mover, and the motor ship Fordonian, a 2,200-ton vessel, has been so converted. This ship is an example of a direct-current installation. She has two two-cycle four-cylinder Diesel engines, each directly connected to two 240 k.w. 200 r.p.m. direct-current generators. These generators supply a double armature 850 b.h.p., 120 r.p.m. motor directly coupled to the propeller shaft. The trawler Mariner is also equipped with two Diesel driven direct-current generators, supplying current to a single motor.

So much for the progress which is being made with this method of propulsion. The many methods of applying the electric drive to the propulsion of ships divide themselves naturally into two main classes, the alternating-current system and the direct-current system,

and must be considered separately. The former is always employed with high-speed turbines, and the latter with internal-combustion engines.

The alternating-current system may then be regarded primarily as a speed-reducing device, and the success of the geared-turbine drive for ships of all classes has proved the necessity of some type of speed-reducing mechanism between the turbine and the propeller. This need is felt to a very much greater extent in slow vessels than in fast ones, but so great are the economies introduced that, in 1912, the Admiralty adopted gearing for the torpedo-boat destroyers Leonidas and Lucifer, of 22,500 h.p. on two shafts.

Mr. R. J. Walker, in a paper read before the North-East Coast Institution of Engineers and Shipbuilders, in December, 1919, said that: "The introduction of this gearing permitted an increase in propeller efficiency of about 12 per cent., an additional improvement in the steam consumption of the turbines of about 10 per cent. at full power and about 30 per cent. at $\frac{1}{10}$ full power, and a slight saving in the total weight of the machinery as compared with the twin-screw arrangement with direct-driving turbines hitherto adopted in this class of vessel." About 30 to 1 is the maximum ratio which has been employed with a single-reduction gearing, while, with double-reduction gearing, very much higher ratios can be employed. The efficiency of single-reduction gearing may be as high as 98½ per cent., while, with double-reduction gearing, 97 per cent. should be obtained. Again quoting from Mr. Walker's paper—"the increased efficiency obtainable with the double-reduction scheme and higher-pressure steam turbines as compared with turbines in association with single-reduction gearing is, in some cases, as much as 7 per cent." This again goes to show the great advantages that are to be gained in decreasing the speed of the propeller and increasing that of the turbine.

It is necessary to harp somewhat on the results gained by mechanical gearing before passing on to the electric drive, as the figures obtainable in this country with regard to the latter are so very scanty, but the speed-ratio economies of the mechanical-geared drive are open to the electric drive, and although its efficiency is lower, say 90 or 92 per cent. as compared with the 97 per cent. of the mechanical gear, it has other advantages.

## Essential Requirements.

In order to discuss the suitability of the electric drive for marine purposes, it will be advantageous to consider the chief requisites of marine propulsion and to see how the electric drive adapts itself to the conditions imposed. Briefly we may say that the essentials are:—

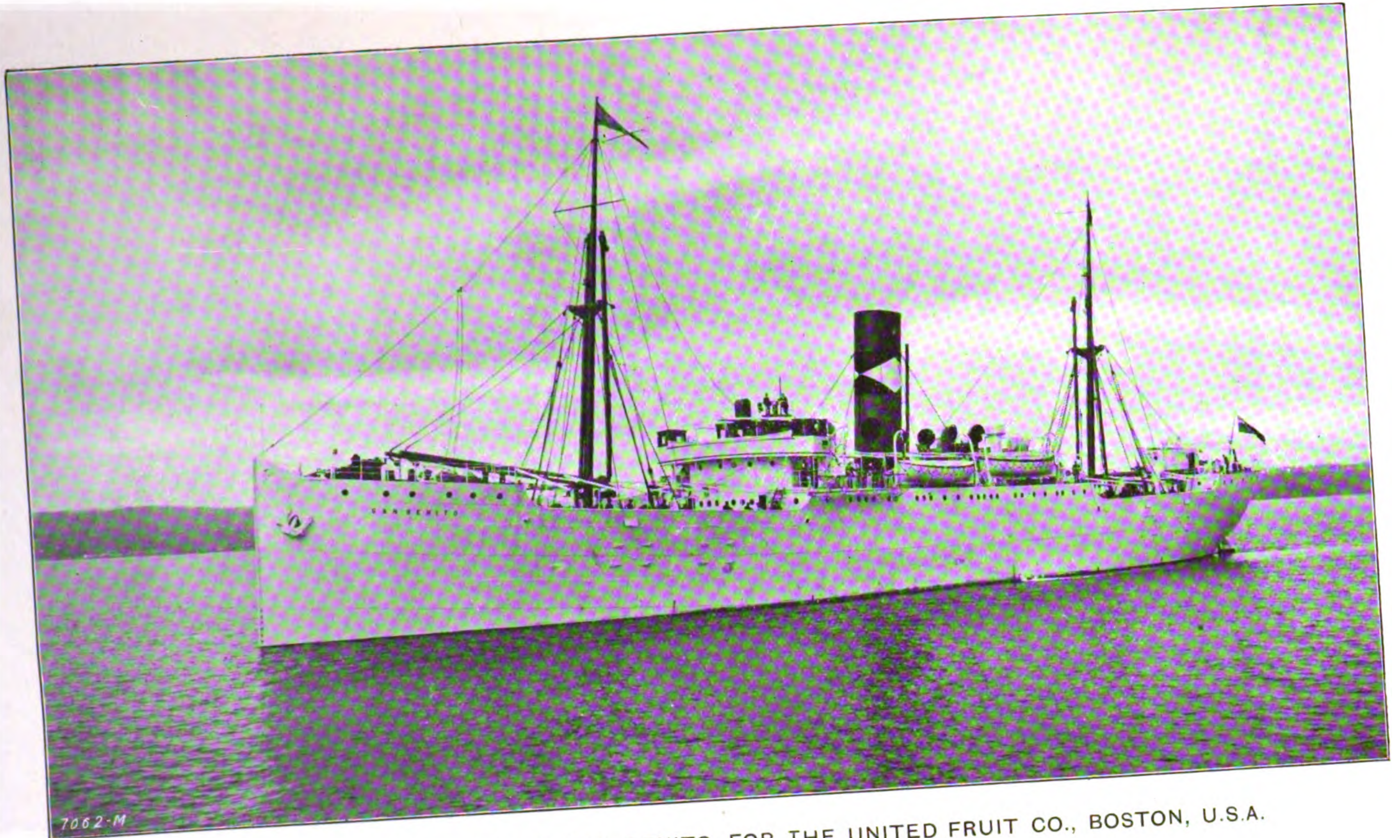
1. Reliability.
2. Economy and low weight.
3. Flexibility of installation and operation.

Reliability is, of course, the first and greatest requisite of every form of marine drive. The past ten years of experience with the mechanical-geared drive has proved the reliability of the high-speed

turbine for marine use. For the high-speed alternator we have but little marine experience, and can only judge it by its performance in land power stations, where it has proved itself to be at least the equal of the high-speed turbine.

Of the actual propulsion motors little need be said. They will be large slow-speed machines, operating within a selected range of voltage, and there is no reason why they should not be made with an ample margin of reliability. The crux of the whole position, from the point of view of reliability, will undoubtedly lie with the switchgear. Of necessity this will be complicated, and will have to deal with large currents at fairly high voltages. It must be fool-proof and elaborately interlocked so that the wrong switches cannot be operated in the stress of sudden and unexpected orders, and, in ships which have to do much manœuvring, it will receive a very considerable amount of use. Nothing but extended practical experience at sea can prove the reliability of this part of the electric drive. We hear little of the failures of the electric drive in America, but it appears to be the general impression that a very large part of the trouble they are having is with the switchgear.

Apart from the reliability of the various components of the electric drive as units, it has inherent characteristics which indirectly make for reliability. As will be seen later (when dealing with flexibility of installation) we are much freer to locate the various units in the most protected parts of the ship than is the case with direct or geared drive, and in a warship, protection of the vital spots is tantamount to reliability. Further, the effect of a breakdown of any one particular part is not so serious as with direct or mechanical geared drive. There are many serious accidents which can happen to a turbine or mechanical gear which necessitate a brake being put on the propeller shaft to prevent its rotating and the consequent dragging of a locked screw is a very great resistance. The speed of a ship may even have to be reduced, as the "jacking gear" may not be strong enough to hold the propeller at the greatest speed given by the remaining units. There are, however, few accidents which could happen to one of the propelling motors to entail the propeller being held stationary, and a freely-rotating propeller does not involve a very great drag. The electric drive affords opportunities for limiting damage. Consider an installation consisting of two turbo-alternator sets supplying current to four main motors, each motor driving a propeller. One main motor may break down. This would mean a loss of 25 per cent. of the propelling power, but, as explained above, only in exceptional circumstances would it entail the extra drag of a fixed screw. One turbo set may break down and in this case the remaining turbo set would carry on with the four driving motors. In the case of a man-of-war, it is probable that full cruising speed would be maintained, and as the damaged set would be completely isolated both mechanically and electrically, any minor breakdown could be repaired. Again in the case of a man-of-war, which would do a great deal of work at cruising speed and not at full speed, only one turbo set would normally be employed at a time, giving a much better opportunity for both sets being kept




ELECTRICALLY-PROPELLED S.S. SAN BENITO, FOR THE UNITED FRUIT CO., BOSTON, U.S.A.

Built by Messrs. Workman, Clark & Co., Ltd., Belfast,

in good tune. An actual instance, demonstrating the reliability which sectionalisation confers, can be quoted. On one occasion while the New Mexico was running at about 17 knots, using both main generators, a small pipe broke which necessitated one turbo set being shut down. In less than 10 seconds all propelling motors were being supplied by the remaining set and the same speed was maintained. With regard to the switchgear, this normally connects both turbo sets with all four motors, and a breakdown in the switchgear would correspond to a breakdown in one motor or in one turbo set, according to the exact spot at which it occurred.

### Risks and Economies.

Fire risks are always serious with electrical apparatus, but it should be possible to guard adequately against these; for the alternators and motors, steam pipes could be laid on to the shrouds or end shields, and effective dampers fitted to the air-circulating system. In the event of a machine burning out and catching fire, the dampers would be shut and steam turned on which would effectively smother the fire. These safeguards are actually fitted to the New Mexico, but there is no record of their having been used. The fumes arising from a serious short circuit, or an arc in the switchgear, would be more difficult to handle, but with proper isolation of this gear and an efficient system of forced draught, this should not prove insuperable.

With regard to economy, if we consider simply the efficiency of transmission, *i.e.* the ratio of the h.p. imparted to the screw to that developed by the turbine, we see that the efficiency of the electric drive is below that of mechanical gears, but it is difficult to obtain sufficiently reliable figures to make an accurate comparison. Mr. Walker, in his paper quoted above, gives an efficiency of over 97 per cent. for double-reduction gearing. On the other hand, the General Electric Company of New York, in their publications, give an efficiency of 94·5 per cent. for apparently similar gearing.

For the electric drive, the latter firm published the results of the tests of the propelling equipment of the steamship Cuba, which had a most complete test at the factory. The motor efficiency is stated to be 95·65 per cent., including excitation; the generator efficiency was 96·3 per cent., giving a combined loss of 7·89 per cent. The cable loss was 0·04 per cent., making the total loss 7·93 per cent. and an overall efficiency of 92·07 per cent. For the electric drive no reversing turbine is necessary, and as this turbine involves a continuous loss of about 1·76 per cent.—again quoting from the figures published by the General Electric Company—this extra loss should be debited against the geared drive when considering it in comparison with the electric drive. The efficiency of the geared drive would thus work out at 92·74 per cent. as against 92·07 per cent. for the electric drive. These figures are naturally insufficient to prove any definite efficiencies, but they are enough to show that the electric drive is a serious competitor to mechanical gearing from the point of view of direct efficiency.

### The Problem of Relative Weight.

The comparison of the weights of the electric drive and the mechanical-geared drive is very difficult, as figures are scarce, and even when obtained it is difficult to know exactly what they cover. The equipment of the electrically-propelled collier Jupiter (7,000 h.p., twin screw) is said to be about 6 tons heavier than the corresponding equipment of her sister ship Neptune, and the General Electric Company of New York state that:—

In low-speed freighters of about 2,500 or 3,000 horse-power, a conservative design of double-reduction type with single unit turbine, as built by the General Electric Company, weighs (including the oiling system) about 9 tons less than electric drive. If, however, with electric drive the motors are put aft, where they really belong, the saving in weight of shaft, bearing supports, shaft alleys, etc., makes the electric drive very much lighter.

In a paper read before the American Institute of Electrical Engineers, Mr. W. E. Thau, of the Westinghouse Co., gave the following estimates of the relative consumptfon of fuel and weight of machinery of a 3,000-ton ship of 11 knots, the geared turbine vessel being taken as unity:—

| Drive. | Fuel consumption. | Machinery weight. |
|---|---|---|
| Geared Turbine . . . . . | 1·0 | 1·0 |
| Turbine Electric . . . . | 1·06 | 1·05 to 1·10 |
| Direct-connected Diesel . . | 0·49 | 1·10 to 1·25 |
| Diesel Electric . . . . . | 0·57 | 0·75 |

In general, it would probably be found that, for destroyers or other high-speed vessels electric drive would be considerably heavier than mechanical gearing, but for battleships, liners, or freighters there would be but little difference in weight. With the greater cost of construction, weight and space difficulties are the most serious that designers have to meet, and although they exist in all classes of ships, they can be better met in larger than in smaller ones.

The electric drive admits of a flexibility of installation which is of great value. To the man-of-war it means that the different parts of the propelling machinery may be placed where they are most convenient, and where they are most protected; to the merchantman that the cargo space is not broken up. It is impossible to have great lengths of steam piping, so the boilers and turbines must be placed close together, and with the turbines go the condensers and other auxiliaries. With mechanical gearing, the gears must come hard up to the turbines and the whole of this assembly must be placed at some point convenient to the propeller shafts. On the other hand, electric cables can be taken for any reasonable distance; the boiler and turbo-alternator section can be placed wherever they most conveniently fit in, and the propelling motors can be placed in the very stern, thus dispensing with a very considerable length of shaft and tunnel.

The flexibility of operation of the electric drive will be apparent

from what has already been said, and, in addition, extremely rapid reversals are made possible. Not only can the power be very rapidly cut off, but the full torque of the main turbines can be utilised to stop and restart the propeller, and a ship can therefore be brought from full speed ahead to full speed astern in a very much shorter time than when only small reversing turbines are used.

Much of the foregoing also applies to the Diesel engine direct-current system, so that there need here be no separate criticism of this system.

## Diesel Engine Electric Drive.

A short study of Mr. James Richardson's two papers in this and the previous issue of "Brassey's Naval and Shipping Annual," will reveal the tremendous possibilities of the Diesel engine. It is obvious that, in the electric drive, this engine will find a valuable ally, so well are they suited for work together. In this case the electric drive may be regarded primarily as a means of connecting any number of engines to a single propeller, while incidentally introducing the advantages of a speed-reducing and reversing device.

The electric drive allows the engine to be designed for the best speed independently of the speed of the propeller, and by enabling any desired number of engines to be employed, irrespective of the number of screws, it permits the utilisation of a conservative output per cylinder. It simplifies the construction of the engines by abolishing the reversing gear, and as the engine need not be stopped and restarted at each reversal, the size of the compressed-air reservoirs can be very considerably reduced. Reversing thus becomes not only simpler but also quicker, as the full torque of the engine can be utilised for stopping and restarting the screw. Further, the engines always rotate at the same speed and in the same direction, the speed of the ship being controlled entirely by electrical means. Flexibility of installation is obtained to an even greater degree than with the turbo-electric drive, as the propelling motors may be placed in the extreme stern of the ship while the Diesel sets may be located in a single engine-room, or spaced in various parts of the ship to suit the general design, without any consideration whatever as to the number and position of the propelling motors. The electric drive has the disadvantage of introducing definite and calculable losses between the turbine coupling and the screw, and gives in exchange indirect advantages and economies which are difficult to estimate with any degree of accuracy. Nothing but extensive trials in various types of ships can settle to what extent the electric drive may be of value.*

Donald Bremner.

* At the end of September, 1921, the San Benito, built by Workman, Clark & Co., Belfast, completed successful trials. The main generating plant consists of a Curtis turbo alternator, installed 'midships, and taking steam from three oil-fired single-ended boilers, fitted with superheaters. The plant supplies power for a large three-phase synchronous motor, which is in a separate motor-room aft, and coupled direct to the propellor shaft. The engines were built by the British Thomson-Houston Company, of Rugby.

## CHAPTER XII.

### Some Broad Aspects of Naval Staff Work.

The "Annual" of 1912 contained the First Lord's Memorandum on a Naval War Staff. He explained that, in establishing a War Staff for the Navy, it was necessary to observe the broad differences of character and circumstances which distinguish naval from military problems, laying special stress on the fact that the problems of transport and supply, the infinite peculiarities of topography which were the increasing study of the General Staffs of Europe, did not affect the naval service, except in an occasional and limited degree. For these and similar reasons, the First Lord held that a Naval War Staff did not require to be designed on the same scale or in the same form as the General Staff of the Army.

A Staff implies nothing that is new. It is simply the logical provision for the preparation for, and management of, the great business of war. Every factory, every large store, railway, and steamship company have their staffs, broadly classified as operative and administrative. If they had not they would fail; and just because the naval advisers to the First Lord in 1912 put into his mouth a dangerous half-truth, which gave rise to a belief that a staff could be brought into being by the mere wave of a magician's wand, the Navy was, at one time, near to failing in the war—due entirely to lack of business management. A few selected officers were put through a special course at the War College at Portsmouth and dubbed War Staff Officers; but the fundamentals of Staff work, the framing and dissemination of correct principles, and the formation of a sound common doctrine were neglected. In consequence, the War Staffs at the Admiralty and with the Fleet in 1914, constituted a Staff in name only, besides being too small for the work that confronted them. This, too, was owing to the lack of a thorough appreciation of the situation, which, in its turn, can only be carried out by a thoroughly trained Staff. Still, the principle of the necessity for a Staff had been accepted, and that was a great step forward. In what follows, an attempt is made to deal with some broad aspects of Naval Staff work, and with what may be described as the basic principles of a sound Staff organisation.

### Main Functions of a Staff.

A contributor to last year's "Annual" dealt with the question of the necessity for a Naval Staff under peace conditions, in the course of which he showed how, in 1917, when Viscount Jellicoe

was First Sea Lord, an extensive reorganisation of the Admiralty Naval Staff took place. Lord Jellicoe, as Commander-in-Chief of the Grand Fleet, had seen the consequences of the lack of a properly trained and adequate Staff, and on assuming duty at the Admiralty at once set the forces of reorganisation in motion. This epoch definitely marks the birth of the Naval Staff as we know it to-day.

It is appropriate to discuss first, exactly what a Staff is, and in what its main functions consist. In every sound military organisation there are three broad divisions: Command, Staff, and Line. Command denotes the centre of authority and decision; Staff implies the intellectual and thinking side; while Line represents those who carry out the decisions made by the Command in the light of the appreciation of the situation prepared by the Staff. Thought plays an all-important part in Staff work; while study develops the line which thought should take. But it is essential that thought should be regularised, and to achieve this it is necessary that all Staff officers should be trained to think alike on all matters of principle. Unless this is done, there will be confusion of thought, with consequent confusion in orders—in other words: order, counter-order, disorder. One does not need to search very deeply into the history of the late war in order to find examples of this confusion of thought, which can be attributed definitely to the lack of a trained Staff. Indeed, it has been said that, in war, it is preferable that all should think alike wrongly, than that all should think differently. Thinking differently is a fault which runs like a thread through our naval history. It must be eradicated once for all; and only a sound Staff system can accomplish that end.

Before, however, naval officers can think alike on all matters of principle, correct principles require to be laid down for guidance. Having laid down correct principles, the question of their application arises. The Army, which for many years before the war had a Staff trained to think alike on principles, produced a very excellent little work entitled, "Field Service Regulations, vol. 1," the opening paragraph of which reads as follows: "The principles given in this manual have been evolved by experience, as generally applicable to the leading of troops. They are to be regarded by all ranks as authoritative, for their violation, in the past, has often been followed by mishap, if not by disaster. They should be so thoroughly impressed on the mind of every commander that whenever he has to come to a decision in the field, he instinctively gives them their full weight." The principles laid down in this little book have stood the test of the greatest war in history. No greater praise can be accorded those responsible for its compilation.

## Manuals for Guidance.

It is exactly at this point that the Naval Staff has to begin to-day. True, the 1912 Memorandum stated that "the War Staff is to be the means of sifting, developing and applying the results of history and experience, and of preserving them as a general stock of reasoned opinion available as an aid and as a guide for all who are called upon

to determine, in peace or war, the naval policy of the country." The idea was laudable enough, but no provision was made for the sieve with which to do the sifting. Certain Divisions of the War Staff were constituted at the Admiralty entirely concerned with current business and—a thinking division having been overlooked—conducting that business more or less haphazardly. This has now been provided for by the establishment of a properly constituted Naval Staff College, a Plans or Policy Division, and a Training and Staff Duties Division of the Admiralty Naval Staff. It is a part of the duty of the latter to furnish the Navy with manuals similar to the Army Manual referred to above. By this means, and by systematic training, the task of Naval Command, Staff, and Line in war becomes enormously simplified, and it becomes assured that the decisions of the Command will be correctly interpreted by the Line, and that the Staff will prepare the necessary orders confident that they will be in keeping with the general idea of the Command, and thoroughly understood by the Line. The Line itself will benefit by clear-cut decisions and will know that, by acting on well-defined principles, it is furthering the object of the Command. Above all, it will foster initiative, as every subordinate commander faced with a situation for which his orders or instructions do not provide, will know instinctively what to do, and having done it, will feel assured that he has acted in the manner that his superior, had he been present, would have ordered. Expressed in another way, it will ensure team work, instead of individual effort, some of which is bound to be wrongly directed.

## THE NAVAL STAFF COLLEGE.

The work of the Naval Staff College is largely concerned with making its graduates think alike on general principles. Differences of opinion will, of course, exist amongst the students, more especially at first, owing to the absence, as yet, of any common doctrine of naval warfare. The truth can only be arrived at by infinite pains on the part of the instructors; by research; by discussion and debate. It is essential that the students should keep open and unbiased minds, so as to avoid the acceptance of dogma, or of hasty deductions based on inadequate research.

But having got the Staff College graduates to think alike on sound general principles, the matter must not be allowed to rest there. It is necessary that the whole corps of officers should be guided by the same principles, or, to use a very expressive and comprehensive term—indoctrinated. As pointed out previously, this is the function of the Training and Staff Duties Division, which besides having general supervision of the Staff College, studies the strategical and tactical principles of employment of forces in war and, with the approval of the Chief of Staff, embodies the conclusions reached in manuals for use by the Fleet.

The title of this chapter is "Some Broad Aspects of Naval Staff Work." Having read so far, readers may possibly ask, when is the subject to be tackled? It is submitted that, as the Naval Staff is yet

in its infancy, the most important feature, and one which will make or mar its progress to a healthy manhood, is that of principles and doctrine. Now is the time to lay the foundation firmly. If laid on the sands of incorrect principles and unsound doctrine it will inevitably be washed away by the floods of war. Moreover, every officer in the Fleet can assist in the laying of the foundation stones and take part in the subsequent building. A few only can undergo the Staff College course, but private study is open to all. At the Staff College it is wisely recognised that individual study is, at least, as important as the tuition given by the instructors.

At the moment, the British Navy has breathing time. This time should be made the occasion of study by all earnest officers in order to assimilate the lessons of the past with the object of applying them to the future. The main thing is to pursue the right line of study. This is a matter in which the Directorate of Training and Staff should be able to afford the necessary guidance in order that, when the time for practical exercises arrives, those who have studied will be able to gain infinitely more valuable experience from them than was the case in the past. Conversely, these officers will be in a position to assist the Staff by forwarding suggestions based on their experiences. By this means, both the Navy and the nation will benefit enormously.

## Position of Staff Officers.

To turn to the more general aspects of Naval Staff work. As said before, there is nothing new in the idea of a Staff. A Staff system is not the end, but merely the means to an end—success in the business of war. Staff officers are not Olympians—and Heaven forbid that our Naval Staff should ever thus consider themselves. They are the servants of the Command and the Line. At the same time it is right and proper that they should be regarded as having special qualifications which other officers do not possess, by reason of which both the Command and the Line look to them for advice. This, in itself, gives them a great deal of power. But with power should go responsibility, and being responsible for the advice they give, it is necessary that they should speak their minds freely, irrespective of any considerations of rank. This goes to the very root of a sound Staff system, and it is just this that makes the ultra-conservative type of naval officer antagonistic to the idea of a Staff. Yet a moment's reflection should show him that it is vital that it should be so. In his dealings with the Line, the Staff Officer speaks with the authority of the Command, and is assumed to know the mind of the Command. He must therefore speak frankly, however much his senior the officer he is addressing may be. In his relations with the Command, it is also his duty to express his opinion, more particularly so should he see a decision being taken which his teaching tells him is wrong. But having spoken, whether his advice be taken or not, it becomes his duty to say no more, but to take the necessary steps for the execution of the decision of the Command.

To do this, great tact is required, and unless a Staff Officer possesses it to a high degree, he is almost bound to add to the already sufficiently great friction of war. On the other hand, if he has it and it is combined with deep knowledge, then he acts as a lubricating oil which makes the wheels of command run smoothly without over-heating. This, in its turn, requires a knowledge of psychology, which can only be acquired by means of the study of human nature. A Staff, to be successful, must never lose sight of the fact that the preponderating factor in war, is the human element. It will be admitted generally that, as far as knowledge of the business of war was concerned, the German Great General Staff was second to none. Yet it failed! Why? Surely because it neglected the human factor and had come to regard men as machines.

Viewed from another aspect, this knowledge of human nature is also very necessary. The drafting of orders to bring about the course of action decided upon by the Command, is an important part of a Staff Officer's duty. One man will go farther on an order consisting of a few words than another will go on pages of detailed instructions. Much may be left to one man's initiative and knowledge of principles, which, with another man, requires very careful explanation. A Staff can be judged by its orders. Instruction in writing orders rightly holds a prominent place in the curriculum of the Naval Staff College; but is sufficient emphasis laid on the necessity of studying the personal characteristics of those who will receive the orders drafted by the Staff? And is it not necessary that some up-to-date method of gauging and recording officers' professional capabilities should be introduced under the supervision of the Admiralty Naval Staff?

The selection of the right men for particular tasks in the event of war is a guarantee of success. What more logical than that the Staff should do this, as they alone are in a position to appreciate the nature of the various tasks?

In discussing the position of Staff Officers, it is necessary to emphasise the fact that the Staff is not a permanent body, in the sense that officers who once qualify for employment on it should fulfil Staff duties indefinitely, to the exclusion of other service activities. Most certainly this should not be so; and it is essential, for the efficient working of the machine, that officers, after a stated period of Staff duty, should return for a term to the Line. In no case, however, should a dual performance of Staff and Line duties be permitted. Further, it is fallacious—and if persisted in will eventually prove harmful—to suppose that a good Staff Officer cannot be a good Line Officer, and *vice versâ*. Indeed, when it comes to the question of Command, it will probably be found that the best men for higher command are those in whom are combined good capacity in both spheres, as this combination will ensure that any particular problem of naval warfare is considered in its entirety.

## Navy and Army Staff Work Compared.

So far, the development of the Naval Staff has proceeded on lines identical with those on which the Army General Staff was built up

some years ago. This is quite right and proper, as the Army system has been tested in the fiery furnace of war, but a word of warning appears necessary lest a too slavish copy be made. There are certain broad differences in character between the soldier and sailor which no artificial system can alter. The land is the land and the sea is the sea! The studies of both Staffs certainly require to be on amphibian lines, and there must be a very close liaison and understanding between them; but the salt breezes should ever blow in the council rooms of the Naval Staff.

When it comes to the actual Staff work itself, however, although the main features are the same, Naval Staff work differs from Staff work in the Army in certain particulars. Paradoxically, Naval Staff work is at once more simple and more difficult than Army Staff work. It is more simple, in that it is relieved of that bugbear of the sister service—transport and supply. Take, for example, the mobilisation, strategical concentration, and deployment of an Army Corps, and consider what it involves. Then ponder a moment on the procedure for similar stages in the Navy. A few brief orders and wireless messages, and the first line of the Navy is on its way to occupy the strategical position decided upon beforehand. Meanwhile, the reserve fleets are mobilising; again a simple process as compared with the Army. Imagine the movements necessary as a preliminary to a land battle on a great scale; the arrangements for reserves and supplies during its course, and for advance or retreat as the case may be.

Movements in Naval warfare are infinitely more simple than on land, and moreover, not being almost entirely dependent on human endurance, can and should be carried out with the precision of a railway. But it is for this very reason that Naval Staff work becomes more difficult, or, to be precise, more exacting than Staff work on land. With opposing forces approaching each other at the speed of railway trains, arrangements are necessary to meet all eventualities that can be foreseen, and every responsible person needs to have a thorough knowledge of the part he is required to play in the various contingencies that may arise. This is true also of land warfare, but the importance of the element of time at sea far transcends its importance on land. An opportunity missed in Naval warfare may very conceivably never occur again. A mistake in the movement or direction of deployment of a fleet may spell disaster. The movement and direction of deployment depends on reports from the scouting forces. These reports have to be dealt with rapidly, which in its turn requires very careful organisation in the matter of communications. Everything turns on time. "Time," said Nelson, "time is everything, five minutes makes the difference between victory and defeat." If he were alive to-day he would say five seconds.

It can be said fairly, that a large initial strategical mistake in land warfare is generally irretrievable, whereas an error in tactics on a large scale is remediable. In sea warfare, the converse is the case. This is primarily due to the relative speeds at which the land and sea forces function, to the difference in facility and precision of movements, and to the influence of topography on land warfare. As a natural consequence, it follows that the decisions of the higher

command at sea, require to be made and translated into orders much more rapidly than is the case on land. To put the matter in another way: a large part of Army Staff work in war, consists of the contemplation of huge masses of humanity, the sifting of every atom of intelligence, and a constant appreciation of the situation in order to be ready to throw a preponderating force suddenly against a weak spot in the enemy's line, or on to an exposed flank. In the Navy, it largely consists in the preparation of a number of concentrated essences of Naval warfare, to be kept in bottles, ready to be uncorked and applied at a moment's notice.

## Co-ordination of Activities.

Whilst the question of battle in the main theatre of operations must ever hold the first place in Staff work, there are other aspects which must be discussed briefly. Here, again, one notes a difference between Naval and Military Staff work in war, which tends to make the former more difficult. On land, the co-ordination of all activities in a theatre of war is a more simple matter than is the case at sea. For instance, on land the organisation and security of the lines of communication is directly concerned with the reinforcement and supply of the first-line troops. At sea, the control and security of the lines of communication, focal and terminal areas, is primarily concerned with the supplies for the country and the transport and maintenance of troops overseas. They only affect the main fleets or striking forces indirectly, which, in fact, fulfil the rôle of covering forces to the vessels employed in protecting the lines of communication from sporadic attack. Naval Line of Communication Staff work—to coin a term—assumes very great importance and is not interwoven with the maintenance of the main fleets in the way that Line of Communication Staffs on land are concerned with the main armies. Unless steps are taken to obviate it, this tends to make Naval Staff work to be carried out in watertight compartments. Any one connected with the Admiralty Naval Staff during the war would have been conscious of a great deal of overlapping and wasted effort which might have been spared had any comprehensive scheme for co-ordination been evolved beforehand. This is a pressing matter, which, in importance, ranks next to principle and doctrine.

The greater the number of divisions there are in a Staff, the more this co-ordination becomes necessary. The vast areas covered in naval warfare, the complexity of the problem of the control and security of the trade routes, and the fact that the submarine puts it in the power of an enemy to carry out a continuous long-range *guerre de course,* irrespective of the operations of the main fleets, necessitates more Divisions of the Naval Staff than is the case with the Army. Headquarters' Staff work, to be successful, must be team work. If it becomes departmental, the work of the forces at sea is bound to suffer. Relevant intelligence must be promptly distributed to all Divisions, each must know sufficient of the general situation and of the actions taken by other Divisions, to enable it to play its part in the team. Otherwise it becomes analogous to a blindfolded

team of footballers, all the players of which kick wildly in the direction in which they imagine the goal to lie. Then, too, it is essential that those at sea should have the necessary knowledge of what is taking place, not only in their own particular theatre, but also in adjacent ones. Secrecy is everything in war, but it is submitted that, carried to illogical extremes, it tends to defeat its object. A line must be drawn between what must be told and what should not be told, but the point at which to draw it, is most difficult to determine.

### Sympathy between Staff and Line.

Staff work is a vast subject, and it has only been possible to elaborate what are considered to be the elementary principles as affecting a Naval Staff in its infancy—as ours is. The writer is an "out and out" believer in Staff work, but recognises that it is but the means; not the end. If carefully nursed through the ailments incidental to childhood, the Naval Staff will develop into a body which, by its studies and preparation in time of peace, will ensure that the Navy, not only of this country but of the Empire, will in the event of war, function as one great whole with a maximum of efficiency. Staff work can achieve no more; but in order to attain that end, it is necessary that the Staff should be in sympathy with the Line, and that the Line should respect the Staff and look to it for guidance.

Some of the points raised in this chapter are admittedly debatable, but it is hoped that by stimulating argument and discussion, it may go some little way towards making Staff and Line look at the problem through each other's spectacles, with the vision of sympathy.

H. Rundle.

# CHAPTER XIII.

## The Criticism of War.

Criticism is of two kinds: there is judgment, and there is appreciation. In the common use of the word, criticism means judgment; a pronouncement in which the critic defines what is good and what is bad in a given work. In the criticism of appreciation, the critic is the interpreter of the intention of the artist; what is bad he passes by as of no account, concerning himself solely with what is worthy of study. In both cases, it is clear that the value of criticism depends upon the qualifications of the critic; and it would seem a natural conclusion that the critic, if his judgment or his interpretation is to be worth consideration, must be skilled in the art with which he deals.

It is commonly assumed, however, that the critic, as such, need possess no knowledge of the practice of his chosen art. If he is acquainted with its theory, he is regarded, by virtue of the gift of a mysterious intuition, as competent to judge the practice of the greatest masters. He is able to indicate what is wrong, though he is wholly incapable of explaining how to put it right. He knows what is good, but he cannot tell you why it is good. Some years since, in the case of a famous picture whose authorship was in doubt, the public were edified by the spectacle of learned art critics striving to identify the painter, not by his style, or drawing, or colour, but by the texture of the canvas upon which he wrought.

There is a proverbial gibe to the effect that a critic is one who has failed in the practice of the art whose practice by others he judges. The critic has this defence at least: that even in failing, he has learned enough to appreciate difficulties, and thus to value success of achievement. Nevertheless, it is the fact that the critic of the fine arts, with seldom exceptions, is an amateur and a layman. And the lay critic of the conduct of war falls into the same category. He may know something, and often knows much, of history and of theory; of practice he is, and must be, almost wholly ignorant.

### Amateur Critics as "Experts."

Long before the Great War there were amateur critics of the fighting Services. Some were men of learning, some were not; but both alike were ready to tell the Admiralty and the War Office what they ought to do; to condemn admirals, and to explain their duties to field-officers. Since the war many books have been published in which admirals of the fleet and field-marshals have been severely

reprobated by gentlemen who could neither take a battleship out of harbour nor manœuvre a battalion on parade; and who, perhaps, had never seen the fighting line or a fleet at sea.

These naval and military critics, before the war, when the German menace had stirred in the public mind a faint interest in the fighting services, were called "experts." To do them justice, some of the writers on naval and military affairs deprecated the title. Mr. Spenser Wilkinson, now Professor of Military History at Oxford, who, in his admirable treatises dealing with the intellectual organisation of the Services did more to educate the public than any other writer, used expressly to deny that he was an expert; this title, he justly observed, belonged to professional officers, who alone are really experts. Nevertheless, other lay critics of naval and military conduct felt themselves to be entirely competent to criticise active operations. The present writer was once returning from naval manœuvres in a ship on board which were two distinguished naval experts. Not aspiring to be other than a humble delineator of events, the present writer had finished his work, and spent his days on deck at ease, while the two experts toiled below, working out the strategy and tactics of the admirals on either side. Now and again one would emerge on deck, pallid and careworn, to remark bitterly that, "It is all very well for you—you have only to describe the foam on the waves, and all that," and to plunge below again. The result of these intolerable labours was to explain at length to the British public that all the admirals at sea had committed dreadful blunders.

Those who recall the South African War will remember the mixed multitude of special correspondents who hurried into the fray. Among them was the late G. W. Steevens, the best correspondent a newspaper ever employed. Steevens published no comments upon the direction of operations. His duty, as he conceived it, was to tell the British public what war is like; the conduct of the war he left to the soldiers whose business it was. Mr. H. A. Gwynne, now editor of the *Morning Post*, was Reuter's correspondent in that campaign, as in many others; in his long experience, he had gained more knowledge of the practice of war than many a general; but there was never a word of criticism in his despatches. Other correspondents, amateurs of journalism as of war, knew all about the conduct of war; nevertheless, it seemed good to Lord Kitchener to send them home.

### The Influence of Politics.

During the interval elapsing between the end of the South African War and August, 1914, various students of war were constantly urging the Government, the Admiralty, and the War Office to prepare for what they regarded, and rightly regarded, as the inevitable conflict. In this patriotic endeavour, a great soldier, Earl Roberts, V.C., and a great seaman, Lord Charles Beresford, were indefatigable; and although they were supported by several writers of high reputation, they failed. The causes of that failure are

instructive. They were mainly political. Politics make the third factor in the problem of which the other two are amateur theory and professional practice. In the study of war, politics make an essential part. Their exigencies perpetually confuse the main issue, so that it is always necessary to inquire if any given action on the part of the Government is inspired, or partly inspired, by a political motive, in order to estimate its value, because political action influences military conduct.

Again and again during the Great War, the influence of politics upon the conduct of operations was manifest. It was observable when the Government refused to put the whole country under military law; when they postponed conscription; and when in 1917 they neglected to provide the recruits required for the following year. The point is not whether the Government were right or wrong; but that purely military considerations were subordinated to the irrelevant exigencies of party politics. It follows that criticism of the conduct of war must include the criticism of politics. And experience, most unfortunately, demonstrates that the critics themselves are occasionally influenced by political partisanship.

Nevertheless, it would seem to be the fact that the existence of the powerful political element makes the critic necessary. A writer may be unskilled in the practice of war, a knowledge of which is only acquired by a professional education; but he may thoroughly understand politics. And under existing systems of governance, politics are the first consideration in war. In this country, supreme power is vested in Parliament, which confides its exercise to a committee called the Cabinet. The Cabinet frames the foreign policy of the nation; upon that foreign policy depends the strength of the fighting services, because they must be enabled to carry the requirements of foreign policy into execution. Before the war, for instance, the foreign policy of Germany demanded a nation in arms.

The critic of politics, therefore, in dealing with the policy of the Government, fulfils an essential duty in educating the public, from whom Parliament derives its authority, and who must suffer and pay for the mistakes of the Cabinet. In practice, the office of critic is discharged by partisans of opposing sides; and as both aspects of the case are thus presented, the public are in a position to frame their own judgment.

### The Duty of the Critic during War.

But upon the declaration of war, it is obviously the duty of the critic to set aside all other considerations, and to judge the policy of the Government solely as that policy conduces, or does not conduce, to victory. The principle of war is at least simple. It consists in using every means to defeat the enemy. Therefore the sole criterion to be applied to the policy of a Government at war, is whether they are, or are not, using every means to defeat the enemy. In what do those means consist? Here, again, the answer is simple. The duty of a Government in war is to place the best sailors and the best soldiers in command, to confide to them the conduct of operations at

sea and in the field, and to supply them with everything they require.

It therefore becomes the duty of the vigilant critic to watch the performance of the Government in both particulars: in their confiding the direction of naval and military operations to the professional authorities and in their furnishing the sailors and soldiers with men, supplies and munitions. The task is sufficiently difficult and delicate to satisfy the most industrious critic. It is often hard to determine whether the intervention of ministers in the conduct of operations is the development of policy which they are responsible for deciding; or if it is an attempt on their part to meddle with the actual carrying into effect of policy. The one is right, the other is wrong,

During the Great War, for instance, the Government decided, as a matter of policy, to force the Dardanelles. It was the business of the critic to examine the policy, as such. It was not his business to explain how it could be carried into execution, or indeed whether it could be carried into execution at all. Professional sailors and soldiers alone were competent to pronounce upon these points; and they alone were competent to decide what would be the effect upon the western front of an eastern diversion of force, and whether or not such diversion were advisable. Here was an example of a policy which might, or might not, be good in itself, but whose practicability depended upon other and purely technical naval and military considerations; and while the critic might justly argue the policy, he was not entitled to argue the technical naval and military considerations. His duty was clearly to insist that the Government should make their decision in accordance with naval and military advice.

Sailors and soldiers are not infallible; their advice may be mistaken; but in that case, it is at least certain that no layman can do better than the professional men. If sailors and soldiers make mistakes, they cannot be hid. There needs no critic to indicate them. In war, as in other works of art, defects are palpable, and it is merit alone with whose interpretation the critic should be concerned.

### Criticism and Secrecy.

Again, in watching the punctual fulfilment by the Government of the requirements of the Navy and the Army, the vigilant critic finds that, in practice, there is seldom any doubt as to what those requirements are. Although seamen and soldiers are not permitted to inform the public, in war there are so many people concerned, and the necessity is so urgent, that the matter cannot be kept secret. During the war, for instance, the need for guns and for ammunition speedily became notorious, and the lack of light craft in the Navy was known from the beginning. It is not only the right but the duty of students of affairs, whose business it is to instruct the public, to make these things known, in so far as they can be known without giving information to the enemy. And here, it will be observed, is

no question of meddling in technical matters; for the requirements of the Navy and of the Army are first formulated by the sailors and soldiers themselves, and what becomes known of their demands is probably rather less than more of what is actually required. It is a sound maxim that in war you cannot give the fighting Services too much.

Here, then, is the first and legitimate task of the critic: to inform the public concerning policy, distinguishing between measures tainted by motives of political expediency and measures directed solely to the right conduct of the war; to mark political interference in technical matters; and to insist upon the instant and complete fulfilment of naval and military requirements. There is another, not less momentous, duty, which is also a privilege. It is to do justice to the achievements of the fighting Services. Any fool can find fault. Only the just and the instructed person can rightly appreciate nobility of accomplishment; and it is his business so to interpret it that the public may understand. In this connection, the official correspondents accredited to the Press during the war, deserve the gratitude of the nation. Constantly writing under desperate conditions: cold, wet through, hungry, thirsty, or toiling in tropical heat, frequently in danger, always pressed for lack of time, severely limited in what might be said and what might not, labouring under the permanent difficulty of discovering exactly what had happened, and being all the while responsible for the right information of the public: these men produced most wonderful work.

## CENSORSHIP.

In connection with criticism during the war, the institution of the censorship falls to be considered. Its necessity surely needs no demonstration. Here, again, none save the professional sailor or soldier is competent to decide what information might be of use to the enemy. He alone knows the value of things; and he is wholly unaffected, on the one side, by political considerations, and on the other, by commercial influences. The Censor's Department at the Admiralty, of which Rear-Admiral Sir Douglas Brownrigg was the chief, was an example of what censorship should be. There are few labours involving a severer trial of patience and temper; perhaps none is more ungrateful. Sir Douglas Brownrigg was inexorable. Neither politician nor newspaper proprietor deflected him a hair's-breadth. He had a short way with him; he was perfectly just; he never lost his temper under any provocation; he worked all day and all night; and he and his colleagues performed a great public service.

With the release of the censorship arrived some examples of what would have happened during the war had there been no such wholesome restraint. Admirals, field-marshals and generals were assailed; all sorts of inaccurate and injurious histories appeared; confidences were dishonourably revealed; and intimate narratives of an extraordinary vulgarity had a great sale. There can be no law forbidding these things. There is, however, an unwritten

code of honourable obligation, which the present writer has tried to expound.

The Royal Institute of British Architects, the governing body of the architectural profession, has formulated a Code of Professional Conduct, which is binding upon all its members. Neither journalism nor authorship is a recognised profession. For that reason, it would seem rather more requisite than less, that a Code of Professional Conduct governing these occupations should be defined, published, and—so far as is practicable—enforced.

L. Cope Cornford.

## CHAPTER XIV.

### BOOKS DEALING WITH THE GREAT WAR—NAVY AND MERCANTILE MARINE.

[Continued from page 131 of the "Annual" of 1920–1.]

[*Published in England.*]

Chronology of the War. Pt. III.—1918. H.M. Stationery Office.

The Battle of Jutland. Official Despatches with Appendices and a Case of Maps. H.M. Stationery Office.

The Official History of the Great War. The Merchant Navy. Vol. I. Archibald Hurd. London: Murray. 21*s.*

The Official History of the Great War. Seaborne Trade. Vol. I. The Cruiser Period. C. E. Fayle. London: Murray. 21*s.*

"Times" History of the War. Vol. 22 (Index). 42*s.*

Navy Losses. Parly. Paper (House of Commons—200). H.M. Stationery Office.

The Victory at Sea. Rr.-Adm. W. S. Sims—in collaboration with Burton J. Hendrick. London: Murray. 21*s.*

The Fighting at Jutland. Lt.-Comr. H. W. Fawcett. Glasgow: Maclure. 31*s.* 6*d.*

Naval War Chart of the North Sea. Close. 25*s.*

Kiel and Jutland. Comr. G. von Hase. Translated by A. Chambers and F. A. Holt. London: Skeffington. 16*s.*

With the Battle Cruisers. Filson Young. London: Cassell. 25*s.*

The Battle Cruisers at the Action of the Falkland Islands. Comr. Rudolf Verner, R.N. Edited by Col. Willoughby Verner. Memoir of the Author by Harold Hodge. London: Bale & Sons. 42*s.*

The Flight of the "Goeben" and the "Breslau." Adm. Sir A. B. Milne. London: E. Nash. 6*s.*

Tales of Ægean Intrigue. J. C. Lawson. London: Chatto & Windus.

[Reminiscences of a Naval Intelligence Officer in Greece and Crete.]

War Government of the British Dominions. A. B. Keith. Oxford: Clarendon Press.

Government Control of the Operation of Industry in Great Britain and the United States during the World War. Oxford: University Press.

Allied Shipping Control. An Experiment in International Administration. J. A. Salter. Oxford: University Press. 10*s.* 6*d.*

The Law of Naval Warfare. Lieut. J. A. Hall, R.N.V.R. Second Edition, 1921. London: Chapman & Hall. 30*s.*
[The first edition was published in 1914.]

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EDWARD FRASER.

# CHAPTER XV.

## Ordnance and Armour.

It is yet too early to attempt to go fully into post-war progress in ordnance, or to foreshadow the probable lines of development in the various countries. All that can be said is that at no time was more earnest thought being given to such matters by all navies, or more research work being carried out. The more interesting developments which took place during the war were forced upon us by the influence of the submarine and the growth in the power of torpedoes. This, it is interesting to note, was in accordance with an expectation recorded in the "Naval Annual" for 1914, where, in the section on Armour and Ordnance, it was stated that "the feats performed both by the aircraft and by the under-water vessels during the past year have plainly demonstrated that they may have a very real and increasing value for war purposes. It would not be surprising, therefore, if these new munitions of war should have a distinct influence on warship design."

### The Guns of New Ships

Mainly, of course, this influence resulted in the provision of larger guns, with longer ranges and greater powers, and in improved protection for the ships which carried them. That the guns could be increased in size was plainly shown by the fact that 18-in. guns were built in the war and mounted in the Furious, and in the monitors Lord Clive, General Wolfe, and Prince Eugene. As Lord Fisher stated in his "Records," guns of this calibre, "with their enormous shells, were built to make it impossible for the Germans to prevent the Russian millions from landing on the Pomeranian coast." Lord Fisher also mentioned that a 20-in. gun was under consideration before he left the Admiralty, the gun itself weighing 200 tons, and firing a projectile weighing over two tons. Mr. Amery, however, has made it clear that nothing like such an advance is to be made in regard to the guns of the four new capital ships. On August 3, 1921, he stated that, in this matter of design, we are not attempting to steal a march on other Powers, and are only bringing ourselves up to date in modern developments which have already been adopted by our friends and Allies. In view of the fact, he said, that all Japanese and American capital ships laid down since the Hood are being equipped with 16-in. guns, we have been obliged to follow their example, and our new ships will, therefore, be armed with 16-in., and not with 15-in., guns. The Secretary did not disclose what number of weapons will constitute the main armament of the

ships. The six new American battleships of the South Dakota type have twelve 16-in. guns. The six new American battle-cruisers of the Lexington type have eight such weapons. In Japan, the Nagato and Mutsu have eight 16-in. guns, and as regards later battleships, the Secretary of the Admiralty stated on April 6, 1921, in reply to a question in Parliament, that their particulars, as reported in the Press, were:—One ship: 33,800 tons, 23 knots, eight 16-in. guns and eight torpedo tubes; two ships: 40,600 tons, 23 knots, eight or ten 16-in. guns, eight torpedo tubes; and two ships: 43,600 tons, 33 knots, eight 16-in. guns and eight torpedo tubes. In the latest American battleships, the 16-in. guns are mounted in triple turrets, the distribution being similar to that in the eight 16-in. gun ships, except that triple turrets replace the twin turrets in the latter. It would not be surprising if a similar method to that in the South Dakota was adopted in this country. Hitherto, British naval architects and artillerists have not favoured the three-gun turret idea, but America has had experience with it in all her battleship types (with one exception) since the Nevada and Oklahoma were laid down in the autumn of 1912. Italy, Austria, and Russia had also adopted it before the war—it was, in fact, a feature of all the Italian and Austrian battleships of the Dreadnought classes. That British armament firms had been giving their attention to the subject of three-gun turrets was shown by a detailed description of an Armstrong triple gun-mounting in the Armour and Ordnance Section of the "Annual" in 1913. This mounting will be found illustrated on pages 334, 335 and 336 of that issue.

## Progress in the Design and Range of Guns.

The published reports and dispatches of the Naval engagements in the late war do not include ordnance reports, and hence throw very little light on the vexed question of steel and wire *v.* steel guns, which subject has been the source of much discussion for many years. The only quoted case of failure on the British side was in H.M.S. Marlborough, where, owing possibly to the premature explosion of a high-explosive shell in the bore, an inner "A" tube was cracked and a portion of the jacket split off. Each system has its supporters and detractors, and each system has certain peculiar advantages. The arguments usually put forward in favour of the Continental system of steel-hoop construction are the alleged superiority of these guns due to their lightness, the special material from which they are made, and the high ballistics obtainable, which, when expressed in the form of foot-tons of muzzle energy per ton of gun, shows a marked superiority in favour of the Continental system, and were this the only point worth consideration, their point would be proved. This, however, is only one of the very many important considerations to be borne in mind in gun design and construction. In the first place, one of the most direct outcomes when high ballistics are obtained from a light gun is that a greater velocity of recoil is communicated to the gun, which must be suitably resisted. On the assumption that the lengths of recoil

are nominally the same for light and heavy guns of the same calibre, then it stands to reason that the force to be resisted is much greater in the case of the light gun than in the case of the heavy gun; which is just another way of saying that the weight of the mounting must be considerably increased owing to this extra force, and moreover, this not only affects the mounting, but also the ship on which the mounting is placed. It will be apparent, therefore, that the amount saved on the weight of the gun is not so much saved on the weight to be carried by the ship. To arrive at right conclusions it is therefore necessary to compare the foot-tons of energy per ton, not of the gun only, but of the total installation. The question of wear, or life, depends more on the nature of the powder used than on the method of building. In comparing the systems of gun construction, it is universally admitted that the wire gun has the advantage in circumferential strength, and the chief advantage of the wire-wound system is that uniformity of stress is obtained throughout the whole of the material employed in the gun structure to an extent that is impossible in a gun built of steel hoops only. It is much easier to vary the winding tension of the wire accurately than it is to bore and turn long tubes to a thousandth of an inch in order to obtain the required shrinkage. On the other hand, the steel gun is stiffer as a girder, though with stout inner tubes and outer cover, a wire gun can be made with a small amount of droop. This tendency to bend prevents the full advantage being taken of the modern high qualities of steel, since a long gun that has just the minimum sufficiency of circumferential strength will be weak as a girder.

Another method of gun construction which is being revived is the system of auto-frettage, the idea being to lessen cost and time of production. If a hollow thick tube is subjected to an internal pressure great enough to stress the outer fibres to the elastic limit, the inner fibres being stressed far beyond the elastic limit will take up a permanent set. When the pressure is removed, the external layers will shrink back on the internal layers and leave them in a state of compression, thus producing somewhat similar conditions to those obtained in a built-up gun with an infinite number of infinitely thin hoops. Incidentally, this overstrain slightly increases the elastic limit of the material. The idea of raising the elastic limit by permanently stretching with an internal application of pressure is not at all new. The Austrians tried it in the 18th century, by forcing a steel expanding mandrel through the bore; there are English and French patents dating back to 1870; Colonel Rosset made experiments at Turin Gun Factory in 1874; a book by Captain Charles Duguet was published in France in 1885; in 1900 Emery was granted patents in U.S.A.; and the present French Naval investigation was commenced in 1909 by General Jacob. A gun on these lines was built by Messrs. Schneider in 1913; and during the late war, field and 4-inch naval guns were built in France and the United States. It remains to be seen whether this system can be applied so as to obtain equally satisfactory large guns with less expense and trouble than either of the present methods.

For the past 50 years, progress in naval guns has been on the lines of increased muzzle energy, calibre, and range, although on occasion a drop back to a smaller calibre has been made. This was particularly the case when the 16·5-inch 110½-ton gun was superseded by the 12-inch 45-ton gun. The following table shows the progress made in muzzle energy, range, and penetration from 1865 to 1917:—

| Date. | Diam. of bore. | Weight of gun. | Weight of projectile. | Muzzle velocity. | Muzzle energy. | Max. angle of elevation. | Range corresponding to angle of elevation. | Penetration of wrot. iron at 1,000 yds. (uncapped). |
|---|---|---|---|---|---|---|---|---|
| | ins. | tons. | lbs. | f.-s. | f.-t. | Range table. | yds. | ins. |
| 1865 . | 7 | 6·5 | 115 | 1,525 | 1,855 | 12° 29′ | 5,500 | 7·5 |
| 1865–7. | 10 | 18 | 410 | 1,379 | 5,405 | 13° 12′ | 6,000 | 11·7 |
| | 11 | 25 | 546 | 1,360 | 7,000 | 12° 56′ | 6,000 | 13·1 |
| 1870-73 | 12 | 35 | 714 | 1,390 | 9,565 | 12° 8′ | 6,000 | 14·6 |
| | 12·5 | 38 | 820 | 1,575 | 14,105 | 10° 47′ | 6,500 | 17·7 |
| | 16 | 80 | 1,700 | 1,590 | 29,800 | 12° 39′ | 8,000 | 23·1 |
| 1887 . | 16·25 | 110½ | 1,800 | 2,087 | 54,365 | 12° 15′ | 12,000 | 34·5 |
| | | | | | | actual. | | |
| 1891 . | 12 | 45 | 714 | 1,914 | 18,140 | 13° 30′ | 10,000 | 23·6 |
| 1892 . | 13·5 | 69 | 1,250 | 2,016 | 35,225 | 14° 8′ | 12,000 | 30·5 |
| 1896 . | 12 | 46 | 850 | 2,350 | 32,550 | 13° 30′ | 13,700 | 33·2 |
| 1901 . | 12 | 50 | 850 | 2,433 | 39,000 | 13° 30′ | 14,300 | 34·4 |
| 1906 . | 12 | 58 | 850 | 2,700 | 42,965 | 13° 30′ | 19,000 | 42·0 |
| 1909 . | 12 | 63¾ | 850 | 2,825 | 47,035 | 15° 0′ | 21,500 | 45·1 |
| 1910 . | 13·5 | 76 | 1,400 | 2,450 | 58,270 | 20° 0′ | 23,500 | 47·25 |
| 1913 . | 15 | 97 | 1,900 | 2,500 | 82,310 | 20° 0′ | 24,500 | 52·6 |

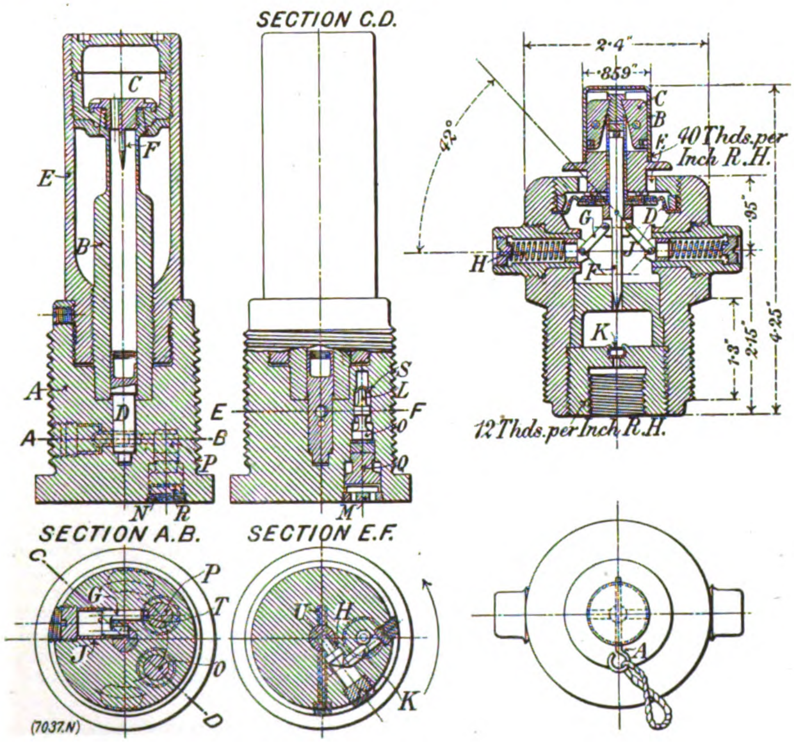
## Improved Fuses.

As is now well known, the type of fuse in use before the war was proved by hostilities to be very deficient, as well as the charge of the shell. Lord Jellicoe mentions in his book, among the five principal points affecting material to which attention was directed immediately after Jutland, the pressing need for an improved fuse for armour-piercing projectiles. One of the leading firms which devoted their energies to this question was Messrs. Thos. Firth and Sons, of Sheffield. Before the war, this firm had produced a base fuse for use with high explosives in armour-piercing and semi-armour-piercing projectiles which, in subsequent practice, was shown to supersede all other types. It was adopted before the war by the Greek Navy, and is still used by them. This fuse has a delayed action, in that the travel of the detonator to the firing needle gives time for the shell to perforate the armour, and its efficiency was proved by actual firing trials before its adoption. It was also tested for oblique impact satisfactorily. Had the Grand Fleet been using this fuse at the Battle of Jutland, the accurate fire of the ships would have inflicted much greater damage on the German vessels. A drawing of this fuse is reproduced on page 167, and the following is a description of its working:—

The fuse consists essentially of an aluminium bronze body (A), steel tube (B), needle (F), expansion chamber (C), detonator pellet (D), steel gaine (E), which contains the detonating composition.

The safety arrangements consist of two non-rusting transverse steel bolts (G and H) which secure the detonator pellet in the safety or rear position in the fuze. These two bolts cannot leave their position until the fuse has been fired from the

gun, their movement being prevented, in the case of the transverse bolt or hook (G), by the brass cup (J), and, in the case of the centrifugal bolt (H), by another bolt (K) held in place by the shoulder of the vertical punch (L); neither of these bolts is allowed any appreciable movement and consequently they retain the detonator pellet in its rear position until the fuse has been actually fired from the gun as described below. Further, were it possible to subject the fuse to such extremely rough usage that the detonator were to explode in its rear seating while still held back by the safety bolts, the detonation would be entirely localised, and could not extend to the composition packed in the gaine (E) owing to the fact that the detonator is securely enclosed by the steel tube (B), the strength of which at the rear end is amply sufficient to withstand the explosion of the detonator, while at the forward, or "thin," end of the tube, the wave of pressure due to the explosion is not only greatly reduced owing to the distance traversed, but the hole in the tube (B)




*Base Fuse.* *Hydrostatic Fuse.*

MESSRS. THOS. FIRTH AND SONS, LTD.

leads to the expansion chamber (C) which further reduces the pressure to an amount considerably below that necessary to rupture the "thin" end of the steel tube. There is thus no possibility of an explosion of the shell being caused by a premature action on the part of the fuse.

On firing the projectile from the gun, the chamber pressure, set up by the gases of the propellant, acts simultaneously through the perforation of the steel guard plates (M and N) upon the bases of the two steel plungers (Q and R) driving them forward upon the lead fillings (O and P). It is not possible for any gas from the propellant to pass into the interior of the fuse, this being stopped by copper gas checks, and should there be any possible failure here, the lead fillings, being at the moment under a greater pressure per square inch than that which exists in the chamber of the gun, effectually prevent any further passage.

The pressure upon the lead filling (O) is transmitted to the rear end of the vertical punch (L), which is driven forward and perforates the brass shearing cup

(S). This movement unlocks the centrifugal bolts (K and H), which are now for the first time free to move outward under centrifugal force upon the projectile taking up its rotation in flight.

Simultaneously the pressure transmitted to the lead filling (P) causes the soft material to flow through the channel (T), thus forming a lead wire which presses with such force upon the end of the steel bolt or hook (G) that the latter is driven through the brass cup (J) forcing the shorter bend of the hook out of contact with the detonator pellet, which is now only held back in its safety position during the flight of the projectile by a thin copper wire (U) instead of by the two steel bolts.

The fuse therefore is now, while in flight, in a sensitive condition, the centrifugal bolt (H) and the hook (G) having been completely withdrawn from the detonator pellet (D), upon slight impact, such as when the projectile passes through a ¼-inch steel plate, the momentum of the detonator pellet easily shears the copper wire, and the detonator running along the bore of the steel tube detonates upon striking the firing needle, at the forward end. At the moment of striking the firing needle, the detonator is separated from the special detonating composition in the gaine only by the thin walls of that portion of the steel tube. These walls are completely shattered by the extreme local effect of the detonator, and the detonation is passed on to the composition in the gaine, which in turn detonates and thus brings about the detonation of the bursting charge in the projectile.

In the specification to govern manufacture and inspection, it is provided that the body is to be of special aluminium bronze with an ultimate strength of not less than 40 tons per sq. in. and an elongation of 12 per cent. in 2 inches. The tube and the gaine are to be made of steel. In the base of the body are to be bored holes to take the lead fillings and plungers, the lower end of the holes being tapped to suit the steel guard plates. These holes are so arranged that, on firing, the lead is pressed through two openings, thereby releasing two bolts which pass through the detonator pellet, keeping it in place. A fine hole is bored transversely through body and pellet to take the copper wire which alone keeps the pellet in place when the shell is in flight.

Suitable holes for the introduction of these parts are provided and filled with screwed plugs.

The space between the steel tube and the gaine is to be filled with special explosive, this explosive being separated from the explosion chamber by a cardboard washer.

The materials used in the construction of the smaller parts are as follows:—Safety bolts, non-corrosive nickel steel; shearing cup, brass stamping from plate; vertical punch and plungers, hardened steel; gas check, copper; filling, pure lead; guard plates, steel; pellet, hard bronze; needle, hard steel.

In the specification regarding proof, it was stipulated that the pressure in the chamber of the gun must not be less than 14 tons per square inch. Three fuses were to be tested for safety as follows:—One fuse will be fitted to a 50-lb. steel block, and dropped 20 ft. on to a steel or iron plate. To be dropped once base downwards, once point downwards and once on its side. The fuse must stand this test without firing the exploder charge in the gaine. The remaining two fuses will be tested by firing the detonator at rest. The steel safety tube must not burst nor permit the explosion of the detonator to be communicated to the exploder charge in the gaine.

Messrs. Firth are also the makers of a hydrostatic fuse for use with bombs in under-water attack upon submarines. This method of attacking the "U" boats was strongly advocated by the firm in September, 1914, although it does not appear to have been adopted officially until a considerably later date. The effect of the water hammer, produced by exploding large quantities of high explosive below the surface, was well known, but the Navy was apparently influenced by the effect of mines exploded on and near the surface in the Russo-Japanese War, which did comparatively little damage to well-armoured ships. A drawing of this hydrostatic fuse is also reproduced on page 167. To arm the fuse the safety pin A is removed and the cap B unscrewed, this permits the two claws C to fly outward. The diaphragm D is then free to move downward on pressure from water entering by the spaces E, carrying with it the needle F. The pressure acting through the

links G overcomes the resistance of the springs H. When the diaphragm D reaches the seating J, its further motion is prevented, but the needle F has then passed the dead centre and is driven forward by the springs on to the fulminate cap K. Below the cap is screwed in an ordinary No. 2 gaine which detonates the charge. A pressure of 13 lbs. per sq. in. is required to press the diaphragm on to its seating. (The pressure required will no doubt vary slightly with different fuses.)

### The Struggle between Projectiles and Armour.

As regards the never-ending struggle between projectiles and armour plate ever since the adoption of the latter for naval purposes about the year 1860, an interesting schedule was compiled by Captain T. J. Tresidder, C.M.G., late Royal Engineers, as an appendix to a paper on "The Laws of High-Speed Punching," which was privately circulated last year by Messrs. John Brown and Co., Ltd., of Atlas Works, Sheffield. Captain Tresidder shows that the main stages of progress of the contending elements, and the periods of duration of the several stages up to the outbreak of war, are approximately as follow :—

Armour.

| | |
|---|---|
| Wrought iron ... ... ... ... ... ... ... | From 1860 to 1876. |
| Compound armour (W.I. with steel face) ... ... | „ 1876 to 1891. |
| Homogeneous steel ... ... ... ... ... | „ 1876 to 1914. |
| Face-chilled armour generally ... ... ... ... | „ 1891 to 1914. |
| Face-chilled carburised steel ... ... ... ... | „ 1891 to 1895. |
| Face-chilled carburised nickel-chrome steel ... | „ 1895 to 1914. |

Projectiles.

| | |
|---|---|
| Spherical cast-iron shot ... ... ... ... | From 1860 to 1863. |
| Ogival-headed chilled cast-iron shell ... ... ... | „ 1863 to 1886. |
| Ogival-headed ditto, with wrought-iron cap (tried in England in 1877 and abandoned) | |
| Ogival-headed cast-steel shell ... ... ... ... | „ 1868 to 1886. |
| Ogival-headed forged-steel shell ... ... ... | „ 1887 to 1914. |
| Ogival-headed forged-steel shell with solid cap ... | „ 1894 to 1914. |
| Ogival-headed forged-steel shell with hollow cap ... | „ 1908 to 1914. |

Fluctuations of the Duel.

| Combatants. | Victor. | Period. |
|---|---|---|
| Wrought-iron plate *v.* spherical cast-iron shot ... | Armour. | 1860—1863. |
| Wrought-iron plate *v.* ogival-headed, chilled cast-iron shell ... ... ... ... ... ... ... | Projectile. | 1863—1876. |
| Compound or homogeneous steel *v.* chilled cast-iron shell ... ... ... ... ... ... | Armour. | 1876—1887. |
| Compound or homogeneous steel *v.* forged-steel shell ... ... ... ... ... ... ... | Projectile. | 1887—1891. |
| Face-chilled carburised steel *v.* forged-steel shell | Armour. | 1891—1894. |
| Face-chilled carburised steel *v.* forged-steel shell, capped ... ... ... ... ... ... ... | Projectile | 1894—1914. |

It will be seen that the projectile has had all along the more extended periods of supremacy, and the last of these, up to the commencement of the war, has been a record one. Since the outbreak of hostilities it goes without saying that both sides have redoubled

their efforts to get improved results, but although the war is now happily at an end, some reticence is still to be observed as to the measure of success achieved. The notes which follow, and which deal with the evolution of the modern armour-piercing projectile, have been kindly supplied by an expert, and will be found as illuminating as they are important.

### THE EVOLUTION OF THE MODERN A.P. PROJECTILE.

While the attack of armour has occupied the minds of artillerists ever since its introduction in 1827, it is only within comparatively recent years that the full effort of the science of metallurgy has been brought to bear upon the subject. For some twenty years, during which wrought-iron plates formed the protection for land defences, armour was not considered suitable for warships, and it was not until 1855 that the first armourclad, La Gloire, was designed, to be immediately followed by the British Warrior, as a direct result of the experiences of the combined Fleets in the Crimea. It is true that General Paixhans advocated armour for ships in 1841 as a protection against shells of his invention, but received no encouragement, and indeed the British Admiralty, even as late as 1850, decided against its adoption, after proving that the 32-pdr. would penetrate 6 inches of wrought iron at 400 yds. The Nelson tactics still formed the basic principle guiding the conduct of naval battles, and 400 yds. was, at that time, a respectable range at which an action should be fought—unless it was possible to get nearer. However, with the introduction of armour, naval tactics assumed a different aspect, and it became advantageous to reduce the enemy by standing away at a range sufficient to render his guns ineffective. Thus numerical superiority in guns gave place to superiority in the weight of the heaviest piece, and at this period it may be said that the development of the armour-piercing projectile commenced. The necessity for the concentration of the blow was realised, and with this in mind, and also in order to increase the weight of the shot, inventors departed from the spherical form.

Fired from a smooth bore, the elongated projectile was proved to be less accurate, and to lose its velocity more quickly than the sphere, by reason of its "toppling," and, in 1851, Lancaster brought out his gun with a spiral oval bore, which gave an elongated projectile the desired spin. This was not very successful, the life of the gun being short compared with the smooth bore, and alternative methods of imparting the spin were for some time under trial. The methods used to obtain rotation may be classed under the heads: —

(*a*) Projectiles intended to receive rotation from the front pressure of the air. *E.g.*—

Sir G. Cayley's elongated shot with shoulder flanges, 1852.
Clarke's fish-tailed shot, 1853.
Palliser's elongated shot with three flanges on body, 1854.
Skelton's, with broad spiral grooves on body, 1855.
Biddell's, with continuous screw thread on body, 1861.

(*b*) Projectiles intended to receive rotation by the action of the powder gas. *E.g.*—

Steward's with deep-cut spiral grooves on the base, 1845.

Capt. Anson's with base formed in spiral planes, 1854.
Dr. Grimaldi's four spiral wings at base with ½-inch hole through the body from base to point, 1861.
Findlay's six spiral holes in base, intended to be filled with powder, which on ignition acted in a similar manner to rocket composition.

These, of course, failed, as might be anticipated, and the development of rifled cannon proceeded.

(c) Projectiles for rifled guns having projections corresponding to grooves in the gun. *E.g* —
Lancaster's oval for spiral bore, 1851.
Whitworth's hexagonal, 1855.
Cylinder with wood inserted in four grooves projecting to take gun rifling, 1855.
French cylindrical shot with two projections in iron, 1856.
Cylinder with six saw-tooth grooves, R.G.F., 1856.
Zinc studs to take six grooves, French, La Hitte, 1857.
Service copper-studded projectiles, 1860.
Grooved projectiles for ribbed guns, Krupp.
Grooved projectiles for ribbed guns, Capt. Blakeley, 1863.

(d) Projectiles intended to take rifling by upsetting or expansion.
*E.g.*—Capt. Vandaleur's expanding lead sabot, 1855.
Capt. Eardley Wilmot's rotating expanding copper base, 1855.
Jeffrey's lead-coated expanding, 1861.
Parrott's brass ring cast into a rabbet formed around the base, which was recessed like the teeth of gearing. The brass expanded due to pressure of gas into the grooves of the gun, 1860.

(e) For B.L. Guns. Armstrong's lead-coated to be engraved by rifling, 1860.
This was succeeded by Vavasseur's copper-driving band, from which was evovled the copper-driving band in its present form.
Examples of many of these types may be seen at that exceedingly interesting Museum of Arms and Equipment, the Rotunda, at Woolwich.

## The Trials of 1862.

In January, 1861, a Special Committee was formed by the British War Office to investigate the nature, form and thickness of iron plates best suited for resisting shot, and in April of that year Messrs, Armstrongs received an order for five projectiles of 150-lb., 175-lb., and 200-lb. weight for testing the armour.

The trials commenced in 1862, and, after protracted experiment, the Committee summed up the matter in their report published in 1866 as follows:—

"Steel is a most expensive material for shot; and as we have proved that Palliser's chilled iron is almost, if not entirely, as good as steel, all our projectiles for battering purposes will most probably be made of this material. The proper form of front or head to be given to hardened projectiles for use against iron plates is a subject of much importance. Various forms have been proposed for this purpose.

"Mr. Whitworth relies on the flat-headed form, while most of Sir Wm. Armstrong's projectiles have been round-headed or hemispherical; Major Palliser has used elliptical heads, and lately, in the projectiles for the 13-inch gun, a sharp-pointed form. The flat-headed form is supposed to be right, because it is generally used as the form of a punch. But although a flat-headed punch, when used with a die, will make a nice clean hole in a plate of iron, it by no means follows that a sharp-point or 'centre' punch will make a rugged hole of equal size, with the same, if not greater ease.

"The manufacturer uses the flat-headed punch in order that he may be enabled to cut out a clean hole; but the artilleryman does not care what shaped hole he makes, so long as it is made; and if he has a preference at all, it is for a rugged hole which is difficult to mend or plug up.

"We find in practice that the pointed form is best for the artilleryman, particularly when iron plates are backed by wood."

That the ogival form of head is best for penetration for both normal and oblique attack has never since been disproved, and, with slight modification, it remains the standard practice to-day.

Mention should be made of Prof. the Rev. E. Bashforth's work in connection with the flight of projectiles. Without his perseverance, progress in the development of gunnery would have been very seriously hindered. Further, the knowledge of the range data of projectiles to which it led has been of considerable assistance in the interpretation of the results of trials of armour-piercing projectiles carried out at proof butts, in terms of performance at various ranges under battle conditions. Until about 1866, it was not usual to record the striking velocity of projectiles at trials. The custom of mentioning the weight of the charge used* might until this time have been sufficient for practical purposes, but it is valueless for comparing the performance of guns of different calibres, or estimating the merit of the designs of either guns or projectiles. In 1860, the Navez chronograph was the instrument in use by the Ordnance Committee, but Bashforth designed another upon a different principle, which he used in his experiments. Since then several others have been evolved, but the type invented by Capt. le Boulenge, as improved by Col. Sir Capel Holden, is now almost universally employed in the determination of velocities. In the evolution of the A.P. projectile, the necessity arose for a means of comparing the performance of projectiles of differing calibres or of the same calibre fired at different thicknesses of plate. For this purpose, Jacob De Marres' "Coefficient of Attack" is most widely used, although many others, including especially Tresidder, Krupp, and Davis, have produced formulæ giving a "factor of performance," in which the calibre of the projectile and the thickness of plate are both eliminated. During the ten years following 1866, no definite advance in the quality or adaptation of armour was made, and the Palliser chilled-iron shot remained efficient as the "armour piercer."

## The Introduction of the Cap.

When, however, Messrs. Schneider, of Creusôt, produced steel armour in 1876, to be followed a year later by Messrs. Cammell's compound armour, some compensating improvement in the projectile became necessary, and the direction of this advance was indicated more or less fortuitously, by the discovery of the protection afforded to the head of the projectile through the use of a soft-iron or steel cap. The story of the invention of the cap has been told by several people and in various ways. There appears to be no doubt, however, that Captain English, R.E., was the first to suggest the use of the cap on the point of the projectile. He tells the story in a letter to the *Engineer*, May, 1907, the outline of which is as follows:—

On February 9th, 1878, one round, a 7-in. Palliser shot, was fired against the iron face of a compound plate. This shot broke a hole through and its head was quite uninjured, while three similar rounds

* A custom which became standard when with the fixed elevation mortar the charge was varied in order to obtain the required range.

fired against the steel face of the plate broke up, splashing on the face. Subsequently a 2½-in. iron plate was placed in front of and close against the face of the compound plate, and the head of a 9-in. Palliser shot penetrated 13-in. and remained entire.

English then proposed a corresponding round with W.I. cap with approximately the same thickness of W.I. in front of the point as the iron plate previously used. This shot passed through the plate with the head entire.

The authorities did not proceed with further trials, with the result that capped projectiles were not introduced into the British Service for more than a quarter of a century; after they had been adopted by nearly every other Naval Power.

Since the capped projectiles were not proceeded with in England, other methods of bettering performance had to be sought, and developed along the lines of improvement in the material used by the adoption of steel and in heat-treatment methods.

In 1881, Hadfields commenced to make their cast-steel shot, and this practice was followed by the Royal Laboratory in 1883. Hadfields patented a "Compound A.P." in 1885; a projectile with a hard point and soft body. (See Fig. "A," page 175.)

Vavasseur brought out a "Sheathed Projectile" (1887) with a hard envelope and soft core. (See Fig. "B," page 175.) Holtzer produced their chrome-steel projectile (1886). Armour piercers were also manufactured in forged steel (by Firths and Vickers), and this was the method more generally adopted since the problems surrounding the manufacture and treatment of cast-steel shot are particularly intricate and difficult.

In 1890, Admiral Makaroff revived the cap in Russia, but for the following five years, *i.e.* until 1895, caps were not recognised for general adoption. Harvey produced in 1891 a face-hardened steel plate by means of his cementation process. Plates treated in this manner proved to be very considerably superior to the compound or the steel plate, and the process became standard practice. A few years later, Krupp's method of treatment superseded Harvey's, and was adopted by Sheffield manufacturers in 1895. The Holtzer (French) chrome-steel projectiles took the place of Palliser's chilled shot as the standard for proof of plates, and they were undoubtedly of consistent and excellent quality, although the projectiles manufactured by the Carpenter and Wheeler-Stirling Companies in the United States were, in the opinion of the American Services, at least their equal. Krupps also manufactured a steel shot for which they claimed equality with the best.

In an important paper on "Alloys of Iron and Chromium," read before the Iron and Steel Institute in 1892, Sir Robert Hadfield gave some striking examples of the excellent results obtainable even as far back as 29 years ago. In this paper some examples were given of the armour-piercing projectiles then made by the firm. A 6-in. projectile was fired with normal impact at a 9-in. compound armour plate with a striking velocity of 1,825 ft.-sec. and a striking energy of 2,250 ft.-tons. The face of this plate contained 1·25 per cent. carbon, so that the tests were severe, though, of course, in those days

the face was not hardened by quenching. The projectile perforated the plate to the eighth layer of oak backing, and was recovered whole with no cracks. This shell was only altered one-hundredth of an inch in diameter, and a little over two-tenths of an inch in length. Another round was fired against a 6-in. compound plate, and was found uninjured a mile and a quarter on the other side. A still more remarkable result had been obtained from a 6-in. projectile fired through a 9-in. compound plate. Being uninjured, it was ground, fired a second time, and again penetrated another 9-in. compound plate. It was ground and fired a third time at a 9-in plate face hardened. It is not often that an armour-piercing projectile is fired three times over.

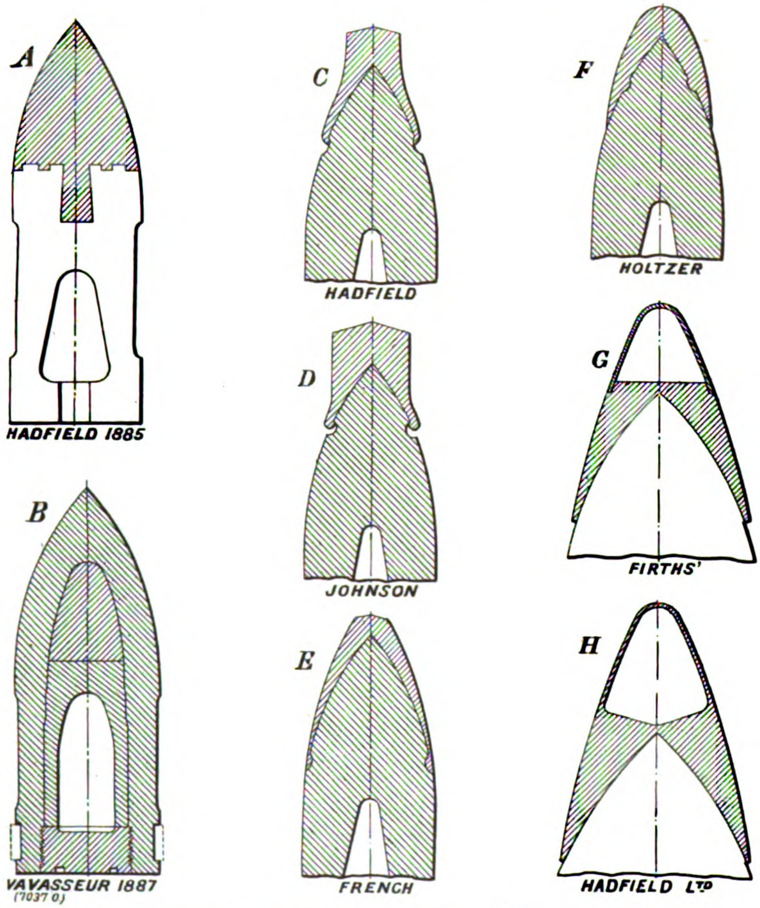
In 1894, Hadfields blunted the points of their cast steel uncapped shot, and with these achieved success at plates which defeated the Holtzer projectiles. In the same year, Firths, with a chrome-steel capped 6-in. shot, succeeded against a 6-in. Harveyed plate at approximately the same velocity as Hadfields' uncapped shot. Up to this time it had not been demonstrated in England that the cap conferred any superiority of performance.

In 1894, trials were carried out at Ochta (Petrograd) with 6-in. Holtzer shot made by Putilof and fitted with Makaroff's cap—generally known as the Russian magnetic cap—which succeeded in perforating a 7-in. Harveyed plate at 20 degrees, with a velocity practically the same as that required for the uncapped or capped shot at the normal. This was a remarkable result, and later experience has tended to confirm the suspicion, current at the time, that the secret of this cap was that it was of hardened steel.

### The Importance of the Bursting Charge.

Up to this time (1894) the armour piercer was looked upon as a projectile purely and simply for perforating armour, that is, it was not expected to carry through the plate a bursting charge; at least not a charge of sufficient weight to be of importance. Indeed, the powder filling contained in the very small cavity was scarcely capable of bursting the body of the projectile. In 1895, the Wheeler-Stirling Company of America produced a "semi-A.P. shell" with a 5 per cent. capacity, which carried its charge through a Harveyed plate two-thirds of its calibre in thickness. This type was further developed by the Firth-Stirling Company in their Rendable Shell of 2½ per cent. capacity (1903), which would perforate a calibre plate unbroken at 2,000 ft.-sec. velocity. This performance became the standard demanded by the Admiralty for A.P. shells. The British capped common pointed shell, with their 6¾ per cent. capacity, are the direct descendants of the Wheeler-Stirling high-capacity shell, but, with their low perforative value, these may be considered to be obsolescent, if not obsolete. The capacity of the A.P. shell proper has been increased until, with the 2¾ per cent. of H.E. filling, it is far more destructive upon life and material than the semi-A.P. with larger charge of powder, while maintaining the high perforative efficiency.

Notwithstanding the success of the Makaroff cap at Ochta, A.P. progress continued with a soft steel cap, and in 1894, 1895, and 1896, the American Government carried out a series of trials at Indian Head with projectiles fitted with the Wheeler-Stirling, Carpenter, and Johnson caps, against hardened armour, at which it was proved that the soft-steel cap added appreciably to the efficiency of the projectile. On the results of these trials, the United States Navy Department, in 1896, acquired the right to use the Johnson




TYPES OF ARMOUR-PIERCING PROJECTILES. (See pages 173 and 176.)

Patent, and introduced the capped shell into their service (U.S. Report, 1897).

In England, manufacturers, particularly Messrs. Vickers, continued strongly to advocate caps, and although France and Russia as well as the United States had adopted them, it was not until 1904 that they were generally admitted into the British Service. The early designs of soft-steel caps are, in the light of modern experience, most crude. In most of them, particularly the Johnson and Hadfield caps, the

mass is too far forward, while the mass of the French cap of this date was so widely distributed as to become too thin for efficiency.

The Holtzer cap, contemporary with these, was of approximately the same percentage weight, but its mass was better distributed. It differed from them, in that it was heat treated, so that its point was stiffened, while the skirt, or open end, remained soft. (See Figs. "C," "D," and "E," page 175.)

It was Colonel Strang, of Messrs. Firths, who, in 1908, first altered the distribution of the mass of the cap to improve its efficiency. This he did by moving the material downwards towards the shell, leaving but little thickness in front of the point. In order to maintain the original external contour of the head for the purpose of flight, he found it necessary to fit a thin-plate deflector to complete the point, and what is now commonly known as the "Hollow Cap" resulted. During the same period, Hadfields were developing on similar lines, and achieved their object with a one-piece hollow cap.

This marked an important advance in the development of the soft cap, and the increased efficiency was fully recognised, not only in England but abroad, so that the hollow cap became standard practice. (See Figs. "F," "G," and "H," page 175.)

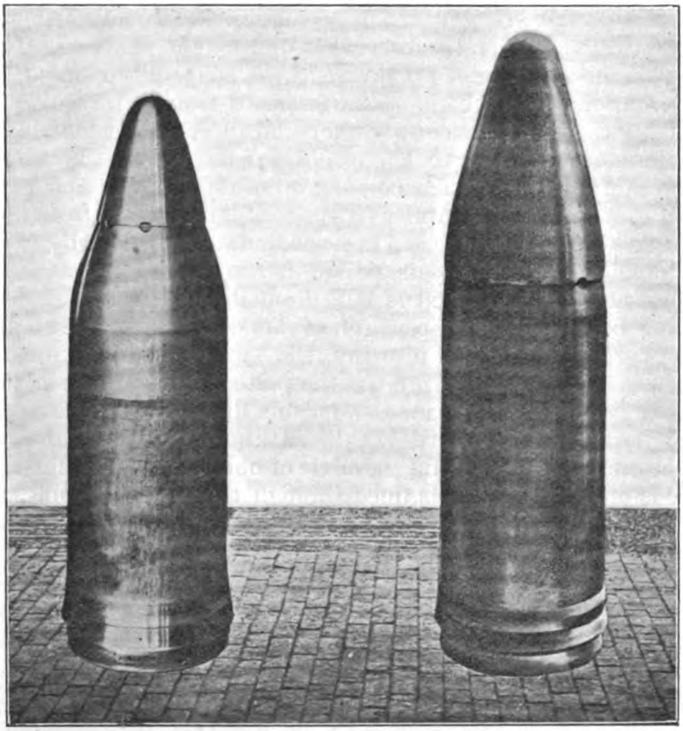
Many theories have been advanced to account for the protective effect of the soft cap, and opinions differ widely as to its action. An able paper was read by Captain Tresidder in 1908, and Sir Robert Hadfield, Sir Trevor Dawson, of Vickers, Limited, and Lieut. H. J. Jones of the A.O.D., have also spoken and written on the subject. The generally accepted principle of its action was enunciated by Major Clerke (Hadfields) in his pamphlet, "The Radial Inertia Theory of Cap Action," published in the "Naval Annual" in 1913. It was there shown by mathematical investigation, that, given a sufficiently thin layer of cap metal in front of the point, there exists at the moment of impact a radial support to the point of the shell equivalent to a pressure of 500 to 1,000 tons per square inch. It was also shown that this pressure varies as the square of the velocity, thus providing means for an intelligent consideration of cap design.

## Oblique Attack.

In following the developments of the soft-steel cap, it must always be remembered that the British proof conditions called for the attack of plates at the normal, with the natural result that both shell and cap gradually became specialised instruments for this purpose, and little or no encouragement was given to manufacturers to progress in knowledge of oblique attack. In 1913, Hadfields patented a hardened cap of special steel with which attack at angles up to 15° was contemplated, and which proved highly successful at Shoeburyness to this extent, enabling the projectile to perforate calibre plates unbroken. Trials at Shoeburyness were also carried out in 1913–14 with shells of Messrs. Firths' manufacture fitted with a special cap for oblique attack. Strong efforts were made by the manufacturers at this time to interest the Admiralty in shells designed specially for the oblique attack of armour, and in the light

of subsequent events it is unfortunate that the matter was not carried forward and the designs proved at this time. In 1915, the Italian Service was already well ahead with trials of Messrs. Firths' projectiles designed for oblique impact.

Until 1916, the world generally was without experience in the oblique attack of armour at angles above 15°, and it was the experience of war, particularly in the Battle of Jutland, that created the imperative demand for development in this direction. The successful attack of calibre plates at 10° with the old type (pre-1916) projectile fitted with the light soft cap, at velocities about 1,900 ft.-sec.,



TYPES OF CAPPED A.P. PROJECTILES.

was more or less established; indeed the American Government proof specification called for the recovery of the shell unbroken after such a test. Similar success at 20° proved, however, to be impossible, except with a striking velocity so high as to limit the effective battle range to an extent which the Dogger Bank and Jutland actions had already proved to be out of the question. Expert opinion was unanimous that the old cap was too light for success at the higher angles of attack, and the typical designs prepared at the Admiralty from information and suggestions furnished by the armament firms, permitted the use of a cap considerably heavier. The illustration on this page shows the difference in external contour of the two types of projectiles.

The manufacture of the first projectiles to these designs followed closely that of the old type, but the results at plate trials showed the necessity for radical modification, not only in their heat treatment but also in the form and distribution of the metal of the cap, and in the position and form of the cavity, while retaining the 2½ per cent. capacity. It will be realised that the stresses which a shell for angle attack is called upon to withstand are entirely different from those experienced in normal attack, and that the function of the cap is vitally different in the two cases. In normal attack, there is little, if any, wracking stress upon the body of the shell, provided that it is steady in flight at the moment of impact. The stresses upon the body at this test are almost purely compressive in the early stages of penetration, subsequently altering to tension as the base enters the hole and the shearing of the driving band takes place, supported as it is by the solid closed base. Such is not the case with angle attack, and the stresses upon the body vary and increase incalculably as the angle of attack increases. The conditions necessitate the utmost care in the manufacture of the steel, and absolute accuracy and control of the processes of heat treatment if successful results are to be obtained.

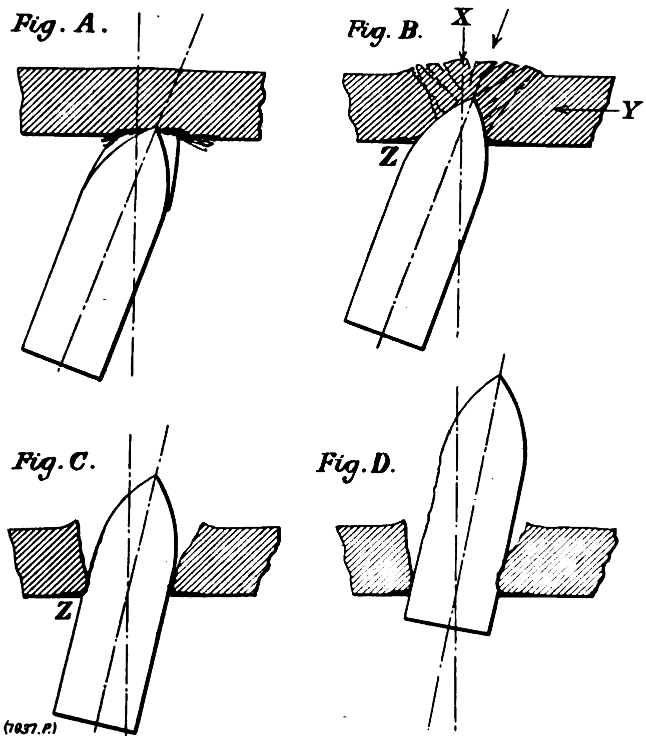
While the duty of the cap in normal attack is primarily to support the point of the shell by its radial inertia during the shell's entry and defeat of the hardened face of the plate, the cap for angle attack (besides being capable of performing this duty should the shell strike at the normal) must also bite into the face of the plate on impact, and on its own initiative prepare the plate for the attack of the shell proper by causing disturbance, and also a disruption, of the face metal. Upon impact, the projectile would naturally tend to glance off the face of the plate, increasing the angle of obliquity; that this does not occur is due to the bite obtained through the cap and point. In its passage through the plate, the projectile actually turns towards the normal by as much as 8° or 10°, by reason, principally, of the transverse resistance of the plate, and, to some extent by the scoring of the body by the plate snags on the acute angle side during the later stages. The sequence of events is shown in the illustration on the opposite page.

## The Lessons of Jutland.

Sir Robert Hadfield, speaking in 1921, called attention to the unfortunate impression which prevailed, until recently, that the German A.P. shells were superior to those of the British Fleet at the time of the Battle of Jutland. He showed that two of the German battle cruisers were reduced to a sinking condition by reason of the repeated perforation of their heavy belt armour, while in no case was British armour similarly perforated. He stated that "having had the exceptional opportunity of examining in a most exhaustive manner modern German (Krupp) armour-piercing shell, and also being in possession of comparative results of plate tests of contemporary German and British armour piercers, it could confidently be asserted that, at the time of the Battle of Jutland, the British ships were armed with the better projectile. Shell of the improved type now

forming the armament of our ships are not only far more efficient than the older type, but are well in advance of anything yet produced by other countries."

We may say, therefore, that in 1920, the armour of the most modern warships was perforable by contemporary projectiles at 30°




PERFORMANCE OF CAPPED A.P. SHELL IN ANGLE ATTACK.

SKETCH A.—Shows the moment after impact when the plate has deformed due to the blow, the disturbance of the face metal, and entry of the point.

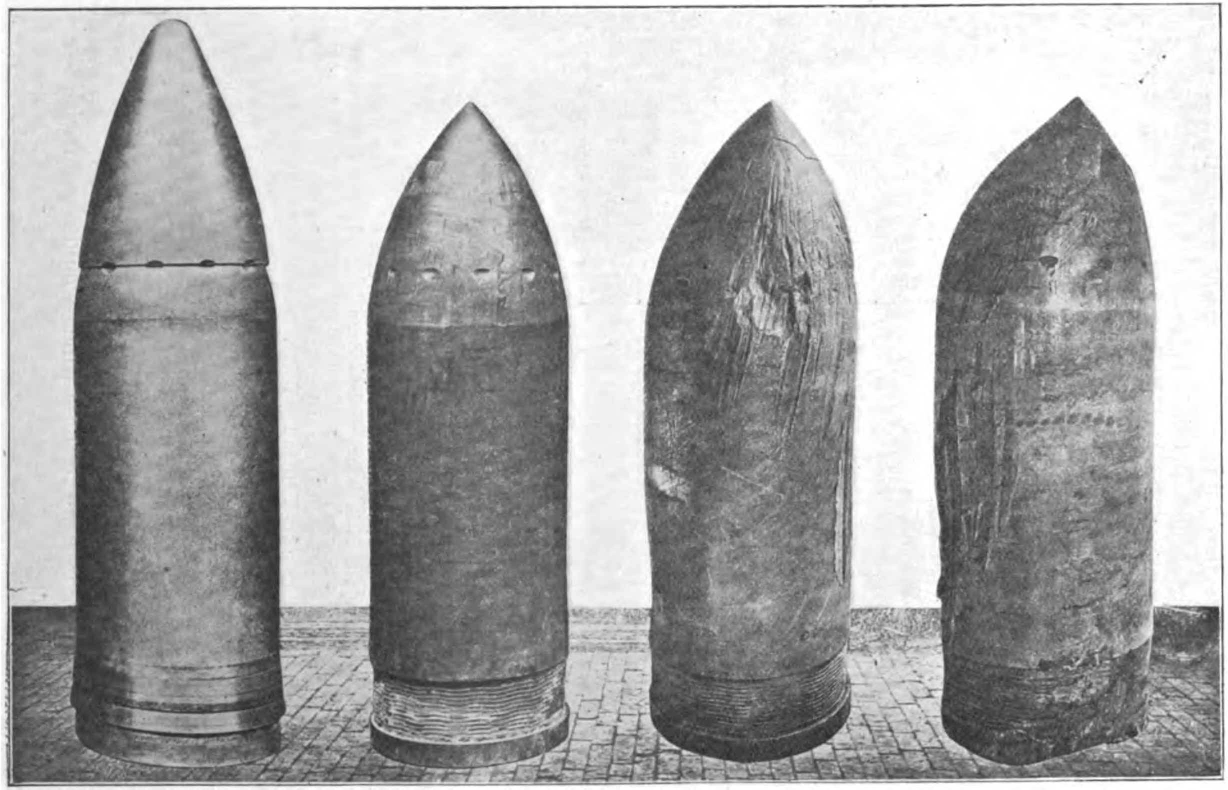
SKETCH B.—Shows the projectile nearly through, having pushed out the disc at the back and so relieved the normal component of the plate resistance X, leaving the transverse component Y in full activity. The effect of this pressure on one side of the ogive deflects the head of the shell from the line of flight towards the normal. Plate snags entering upon their part at the shoulder Z.

SKETCH C.—Shows the head through the plate and the deflection of the shell more pronounced. The snags Z at work.

SKETCH D.—Shows the shell nearly through, the deflection so far advanced that the base of the shell strikes the opposite side of the hole where the plate scoring of the base is commenced, and the final bending stress upon the shell body is being applied.

with velocities approximating to those which would remain with the projectile at battle ranges.

As regards the future, prophecy is always dangerous. Our leading armament firms are prepared to construct guns of 18-inch and even 21-inch bore and to provide armour-piercing projectiles of these calibres. Messrs. Hadfields have already designed a 21-inch



THE POST-WAR ARMOUR-PIERCING PROJECTILE (HADFIELDS).

This plate shows large calibre A.P. projectiles in condition before firing, and after successful attack at the normal, 20° and 30° obliquity. In the 20° and 30° rounds the solid head of the shell is bent over, and the body, besides the heavy plate scoring, is out of truth by as much as 2 and 3 inches, yet the shells were recovered whole and in a condition for bursting.

shell, modelled upon existing practice, which, weighing $2\frac{1}{2}$ tons, and having a muzzle energy of 250,000 foot-tons, would be capable of perforating 24 inches of hard-faced armour at a range of 18,000 yards. The size of the vessels to carry such weapons is prohibitive, since facilities for docking and repair are barely adequate for the present-day leviathans. Moreover, with the menace of submarine and air-craft development, the direction of the evolution of the future battle-ship is still uncertain.

There may next be dealt with the advance which has been made in matters connected with gun mountings, and the improvements in the mechanism for operating naval ordnance. In this respect the following particulars will be found interesting.

### Universal-Link Breech Mechanism.

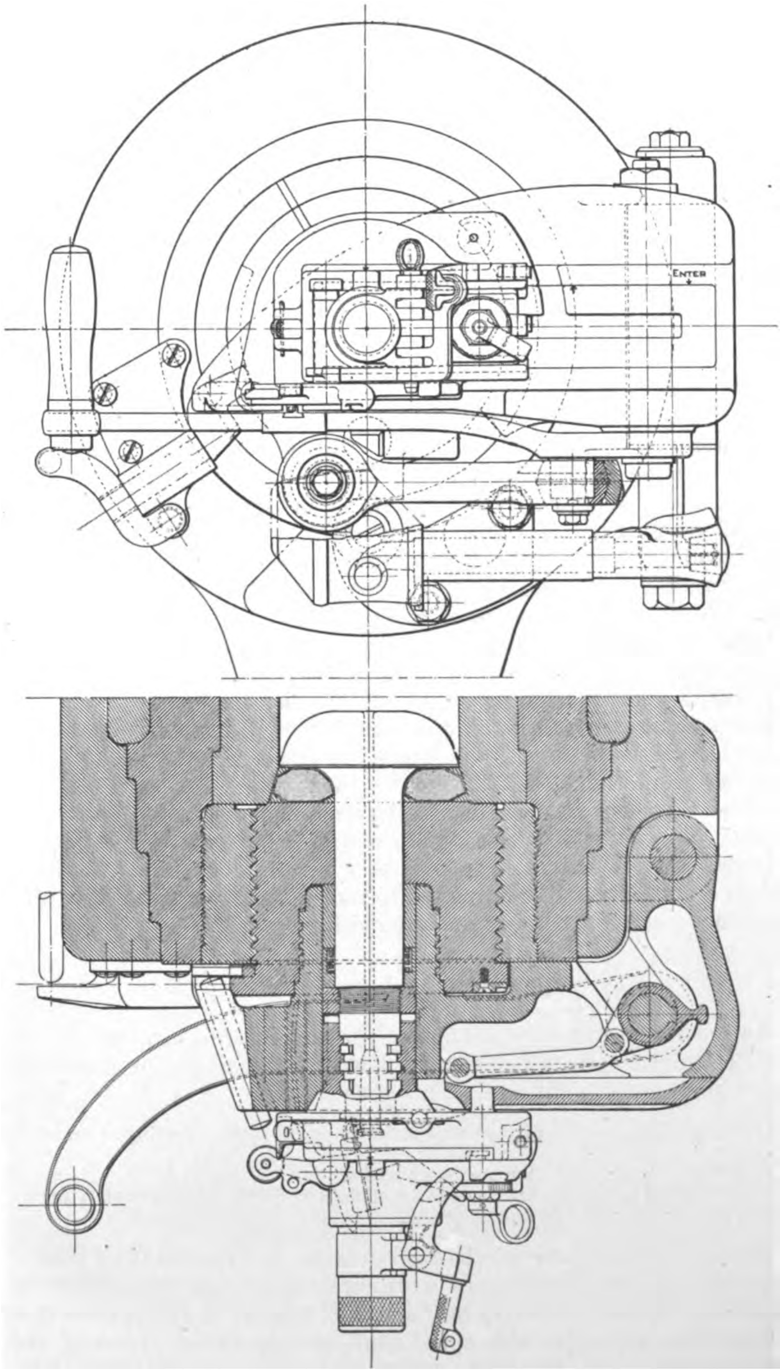
In "The Annual" of 1919, a description was given of the Beardmore universal-link breech mechanism. This has since passed through exhaustive trials. It is now fitted with a safety device on the handlever, which, working in direct conjunction with the lock sear, makes the lock positively safe until the handlever is closed and latched. The safety device consists of a rib on the top of the handlevers interlocking with two lugs on the underside of the sear. The illustration on the next page shows handlever fully home with the sear in bent. The gun can be fired in this position, as the lug on sear will just swing clear of the rear end of the rib. In closing the mechanism the striker is held safe from the time the front end of rib on the handlever (13 inches from home) engages lug on the sear. The striker, in this position (handlever 13 inches from home), is ·725 inch to the right of the centre line of the tube. In the case of hand ejection of primers, this had been modified to give still easier ejection, and if automatic ejection is preferred, this is catered for by the type of lock shown in illustration. This lock still retains the former features of simplicity and uncommon ease of stripping and assembling.

### Power Transmission.

As regards power-transmission apparatus, interest attaches to the new Beardmore electro-mechanical power transmitter for elevating and training gun mountings. This consists of:

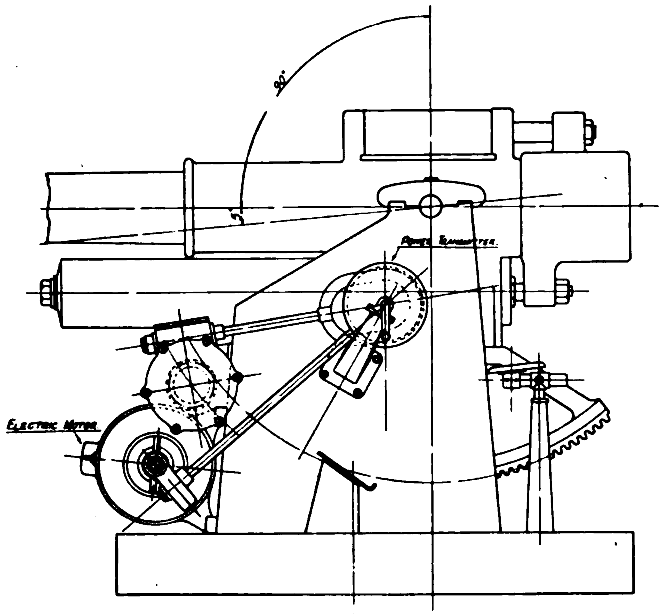
(1) An operating handle pivoted on the driving shaft of an elevating or training gear.
(2) Two double-armed clutch operating levers.
(3) Two clutch discs rotating in opposite directions driven by means of a motor running at constant speed in one direction.

By means of these three mechanical details (1), (2), and (3) a rotary movement in one direction at a uniform speed can be converted (practically instantaneously) into a rotary motion in either direction with an infinitely adjustable speed from zero up to the speed of the rotating discs. The training or elevating can be worked either by hand or motor, the change from one to the other being made through

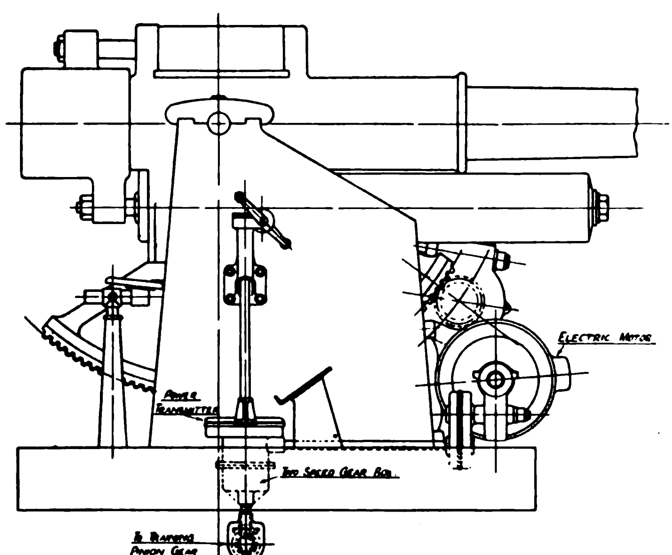



BEARDMORE UNIVERSAL-LINK BREECH MECHANISM.

the medium of a two-speed gear box. The rate of training by power is 8° per turn of handle, and 2° per turn by hand power, whilst for




ELEVATING SIDE GEAR




TRAINING SIDE GEAR.

BEARDMORE ELECTRO-MECHANICAL POWER TRANSMITTER.

elevating, the rate by power is 6° per turn (or higher if required) and by

hand power $1\frac{1}{2}^{\circ}$ per turn of handwheel. The high speeds of training and elevating, in conjunction with the low handle resistance (from 2 to 5 lbs.), enables the gunlayer to keep his sight continuously on the target, in practically any weather conditions.

The following is a detailed description. (For diagram see page 183.)

A handle is pivoted to one end of a spindle. To the other end of the same spindle is attached spur gearing which gears directly, or through intermediate gearing, with the elevating or training wormshaft.

On the spindle there is loosely mounted two discs so designed that they are forced to rotate in opposite directions by a motor which runs constantly in the same direction and at the same speed.

The discs are provided with interior "V"-shaped grooves on rims for engaging the double-armed clutch levers.

The clutch levers are pivoted to a spider keyed to spindle and are operated by handle. When handle is pushed in either direction, it operates levers and forces one or the other clutch blocks into contact with the bevelled sides of the "V"-shaped grooves. A frictional contact is thus established between the handle geared positively to either the elevating or training wormshaft, and the motor.

This enables the motor to supply power for rapidly elevating or training the gun, as the gearing is so designed that the disc engaged by the clutch will always rotate in the same direction as the handle does at the time.

It is claimed for this transmitter that the motor supplies automatically just the right amount of power when required, as it is only reasonable to assume that the moment the operator realises that his crosswire has not got speed enough to follow the target, he, being used to the handworked gear, would exert more pressure on the handle, thus increasing the friction hold, and with it the power supply from the motor, and *vice versâ*, if the crosswires should run past the target. The working of the Beardmore transmitter calls for no special training. A gunlayer might, in fact, work it without realising that it was there, if it were not for the small effort required in the handle. The results from the experiments with this transmitter have been highly satisfactory throughout. There has been no trouble in controlling the speed of the gear so as to keep constantly on the target, and not the slightest "snatchiness" was noticeable when increasing or decreasing the speed.

### Combined Recoil and Air-Recuperating System.

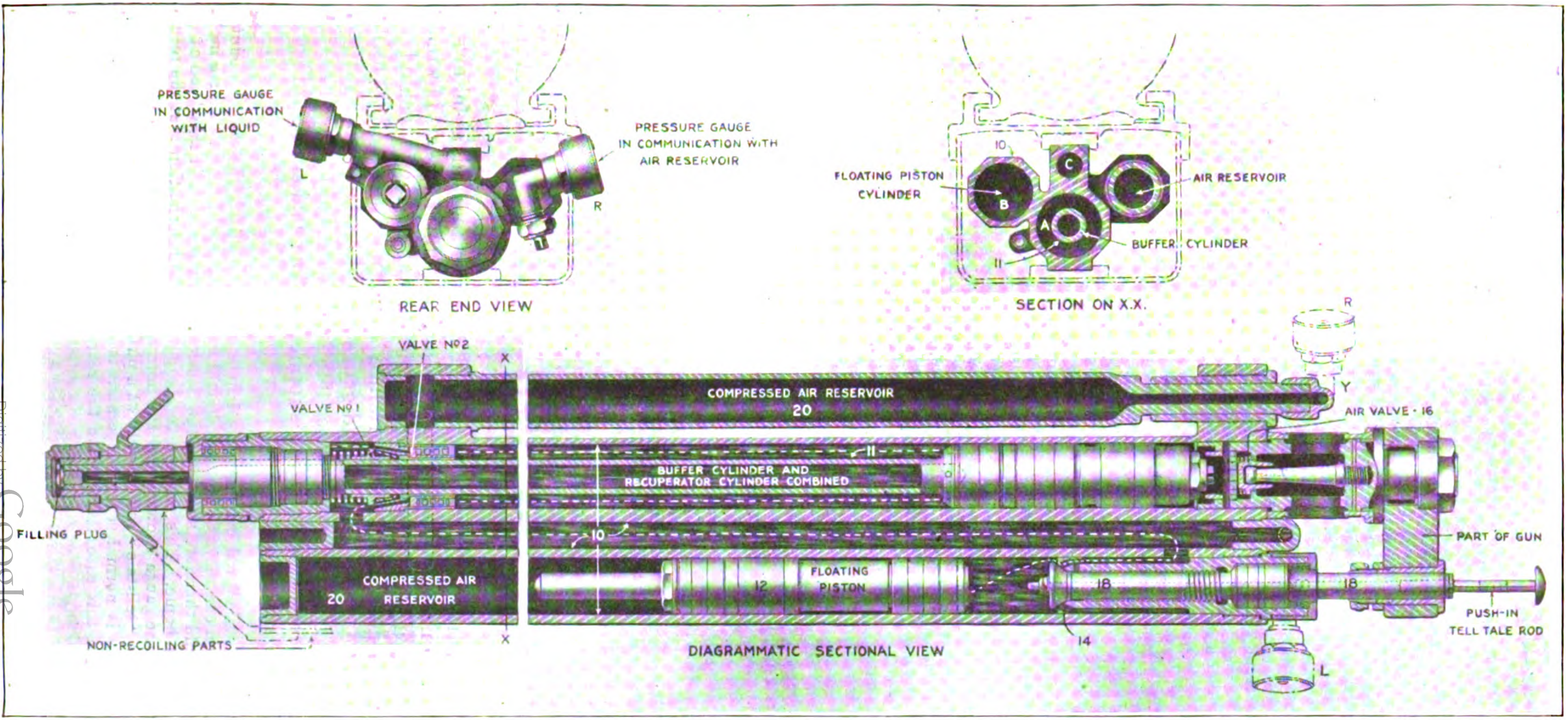
Another new item which will be described, and is illustrated on the opposite page, is Messrs. Beardmore's patented combined recoil and air-recuperating system. This has successfully passed through a very protracted and searching firing test of over 5000 rounds, which is 50 % of its total trial. It is applicable to the lighter naval mountings as well as to field carriages.

As compared with the system at present used in Service Field Carriage Mk. III., it is claimed that the Beardmore system has the following points in its favour.

1.—Number of working pistons, and the corresponding cylinders, has been reduced from three to two, due to the fact that the recoiling mass is both checked and run-out by pressure in the same central cylinder.

2.—The objectionable feature of having grooves in the walls of the recoil cylinder is avoided.

3.—The oil reservoir exposed in front of the shield is done away with.




BEARDMORE'S COMBINED RECOIL AND AIR-RECUPERATING SYSTEM.

4.—No retarding ram is required, as the Beardmore No. 2 valve produces a smoother run-out.

5.—The elaborate details of the automatic recoil cut-off have been abandoned.

6.—Leakage or change in pressure can be observed behind the shield, and remedied without any member of the gun crew having to expose himself in front of the shield.

7.—Any loss of oil takes only a few minutes to make up, as the oil is poured in under atmospheric pressure.

8.—The system claims to be the lightest, and in the case of the Field Carriage Mark III. effects to a saving in weight of over 140 lbs.

The principal details of this combined recoil and air-recuperator system consist of the following:—

A recoiling body (10), a forging which has three cylindrical holes (A, B, and C) running through its whole length, a piston with piston rod (11), and a floating piston (12).

There is, further, a valve (No. 1) which opens at the start of recoil, allowing the liquid to pass on to an adjustable throttling orifice (14). The forcing of the liquid through this orifice (14) produces a resistance which, added to the pressure of the compressed air behind the floating piston (12), brings the recoiling mass to rest when it has recoiled a certain distance.

Another valve (No. 2), spring-loaded, placed behind the one already described, opens fully as soon as the gun starts to return, due to the increased pressure in the air reservoir (20) at this point, but closes gradually when the gun is about halfway from home, as the spring is here strong enough to overcome the reduced pressure in the air reservoir. The action of this valve gives a quick run-out with a very smooth final.

The smooth final is partly due to air which has been drawn into the cylinder (A) through a gauze cover during recoil and trapped by air valve (16). This air is compressed during the run-out, and can only escape slowly through a small adjustable opening.

Although no leakage of air and practically none of liquid was experienced during the first trial of this system, an observation arrangement, as described below, was added and found highly satisfactory.

This arrangement consists of a gauge, which gives the initial (not maximum) pressure inside the recuperator and a "*push-in tell-tale rod*" to ascertain the position of the floating piston, and to determine whether there has been any escape of liquid.

Both pressure gauge and "tell-tale" are placed on the gunner's side of the recuperator. The gauge is always visible to him, and the "tell-tale" constantly within his reach. This keeps the gunner, when sitting behind the shield, well posted up (if desired), from round to round, with regard to any alteration of the conditions inside the recuperator.

The instruction plate secured to the recuperator reads as follows:—

"The gun can be safely fired as long as pointer appears in window of gauge on left side of gun. The amount of liquid behind the floating piston should be ascertained from time to time by pushing in 'tell-tale' rod. If left-hand gauge should be damaged right-hand gauge can be relied on, granted 'tell-tale' can be pushed in." The following further details are supplied by the makers regarding the device last mentioned:

The "tell-tale" rod can be pushed in 3 inches. This is the same amount as floating piston can move to the rear, should leakage of liquid occur. Three inches of liquid would therefore be behind the floating piston, if the "tell-tale" rod can be pushed fully home. This conveys to the gunner the information that the recuperator (when the gauge shows about the normal initial pressure) is in full working order. If the "tell-tale" rod only allows a push-in of ¼ inch, but the pressure shown by the gauge is normal, the recuperator is still in working order. The floating piston has, in this case, travelled to the rear, due to leakage, 2·75 inches from its

normal position, and the time is drawing near when the liquid behind the floating piston should be made up.

If the floating piston still goes on travelling to the rear until it touches part (18), the "tell-tale" rod cannot be pushed in at all, and as the contact between the floating piston (12) and part (18) transfers the air pressure from the liquid to part (18) the pointer will disappear from the window of gauge (L).

Firing the gun under such conditions may give metal-to-metal recoil and an incomplete run-out. To ascertain the amount of liquid which may have escaped, after the floating piston has been in this position—in contact with part (18)—for some time, the gun is elevated as far as possible and the "slide-back" of the gun in the cradle noted.

If the pressure as indicated on the gauge should fall below normal, but the "tell-tale" rod can still be pushed in, it is the air that is leaking out. This can also be confirmed by a duplicate gauge (R) on the right side.

The liquid is made up by screwing in a square-threaded screw (18) as far as it will go, which forces the floating piston to the front. This takes the pressure off the liquid and allows, after the pressure gauge (L) has been removed, the necessary amount of liquid to be poured into the recuperator out of an ordinary oil can.

The air is made up by pumping in air at the rear through pressure gauge hole (Y) on the right side.

## ARMOUR.

The problem of armoured protection of capital ships, both as to the degree of weight which should be assigned for this purpose and as to the best method of distributing it, has reached a very interesting stage. It is not possible to put on record such conclusions as have been reached after prolonged research and experiment, and the full details of the new British battle-cruisers must be awaited to see in what direction our designers have been influenced. Unquestionably a factor of great importance in this respect is the menace of aircraft, in regard to which the data obtained by the United States Navy Department in its series of bombing trials with the ex-German ships as targets was of particular interest. The report of the Joint Army and Navy Board on these trials, it may be recalled, declared that "Aircraft carrying high-capacity, high-explosive bombs of sufficient size have adequate offensive power to sink or seriously damage any naval vessel at present constructed, provided such projectiles can be placed in the water close alongside the vessel. Furthermore, it will be difficult, if not impossible, to build any type of vessel of sufficient strength to withstand the destructive force that can be obtained with the largest bombs that airplanes may be able to carry from shore bases or sheltered harbours. High-capacity, high-explosive bombs hitting the upper works of the vessel are disastrous to exposed personnel, serious to light upper works, comparatively slight to heavy fittings such as guns, and negligible to turrets. The effect of direct hits was completely local. The most serious effect of bombs is the mining effect when such bombs explode close alongside and below the surface of the water." Both in the British and French fleets, similar firing trials have been carried out this year. The French used the ex-German battleship Thuringen for the purpose, and after the tests off Lorient her armour plates were removed for a minute inspection of the penetrating power of the shells used.

Trials have also been undertaken in England this year to test the quality of various types of German armour plates for the purpose of

comparing them with plates of corresponding thickness manufactured in this country. The plates were obtained from the ex-German battleship Baden, and are therefore thoroughly representative of the German product.

The following table, reproduced by permission from *Engineering*, sets forth the results of these trials and indicates the marked superiority of British armour plates. In the table the average limiting velocity of penetration for British plates is taken to be 1,000 ft. per second in each case, and the third column shows the comparative figures for German plates. The shells used at these trials were of similar mark and quality to those used in testing British plates of the same thickness.

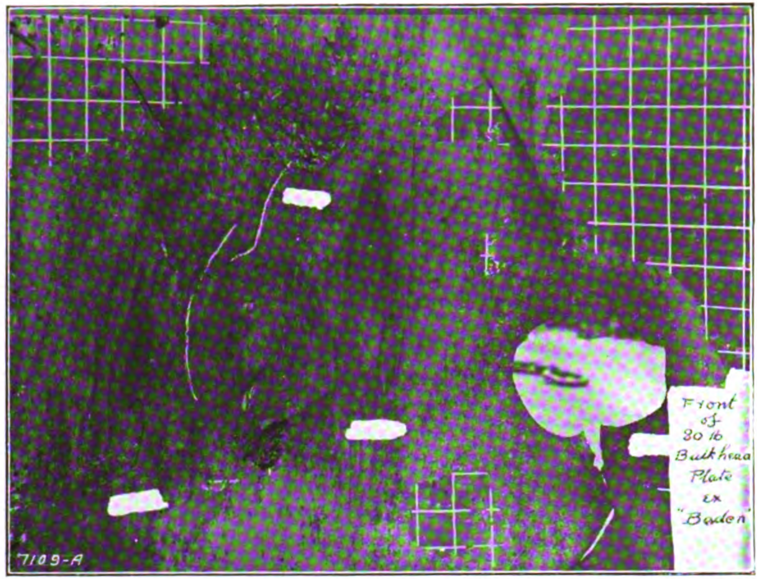
| Thickness of plate in lb. per sq. in. | Index number representing limiting velocity of penetration. | |
|---|---|---|
| | British. | German. |
| 80 Bulkhead plate . . | 1,000 | 1,000 |
| 160 Turret roof plate . | 1,000 | Less than 955* |
| 200 Turret roof plate . | 1,000 | Less than 935* |
| 320 K.C. armour . . . | 1,000 | 940 |
| 400 K.C. armour . . . | 1,000 | Less than 895* |
| 480 K.C. armour . . . | 1,000 | Less than 835* |
| 560 K.C. armour . . . | 1,000 | 915 |

## Improvements in Rangefinders.

It will be readily understood that the developments which took place during the war showed the absolute necessity for more powerful rangefinders. Lord Jellicoe records in his book on the Grand Fleet how, by the test of hostilities, "the effective range both of the gun and of the torpedo was quickly shown to be much greater than had been considered possible before the war." Speaking of the need for improving our rangefinders after the experience at Jutland, he says that the majority of these instruments had been installed in the Fleet before the great increases in the range of opening effective fire had come about. Our most modern ships at Jutland were provided with rangefinders 15 feet in length, but the majority of the ships present were fitted with instruments only 9 feet long, and he refers to the successful steps taken during 1917 to supply rangefinders up to 25 feet and 30 feet in length. In view of the great progress made both then and since, some remarks by a recognised authority on the subject of rangefinders, periscopes, and other kindred instruments will not be out of place here.

It is over thirty years since the attention of Professors Barr and Stroud, who occupied respectively the Chairs of Engineering and Physics at Leeds, was directed to the problem of constructing rangefinding apparatus suitable for war purposes.

* In these cases: owing to the limited space available for attack, the velocities could not be taken low enough to determine the limiting velocity; the shells, at the velocities indicated by the index figures, passing on practically undamaged, except in the case of the 200-lb. roof plate.

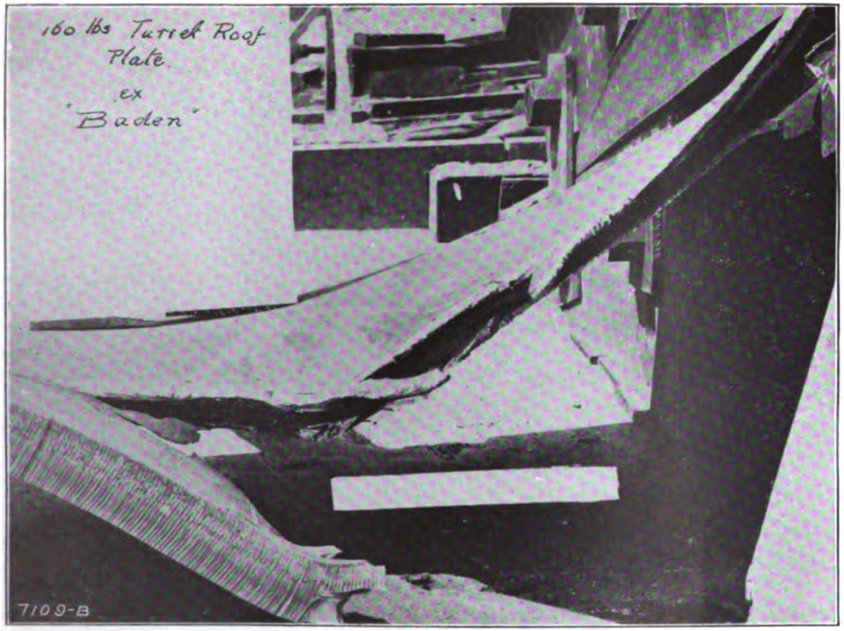



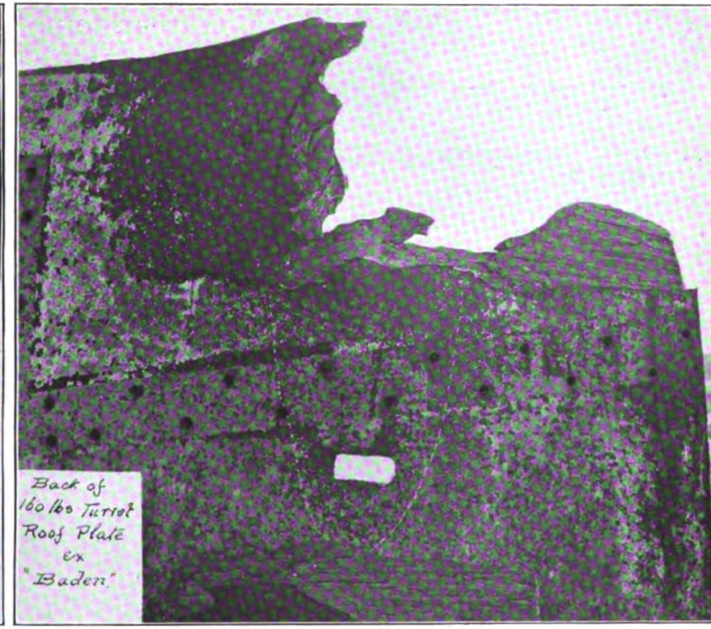

80-lb. per sq. ft.* Bulkhead Plate: Limiting Velocity of Penetration equal to British Plate.

## BRITISH TRIALS OF GERMAN ARMOUR PLATES.

* NOTE.—By an error in the table referring to these trials, on p. 188, the thicknesses are there given in lb. per sq. in.; they should, of course, be lb. per sq. ft.

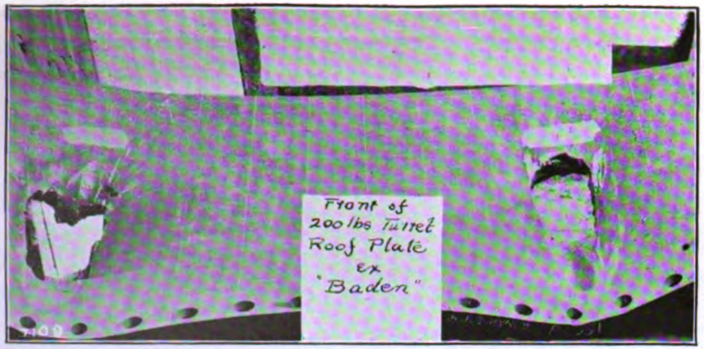
These engravings, and those on the four succeeding Plates, are reproduced from *Engineering*.

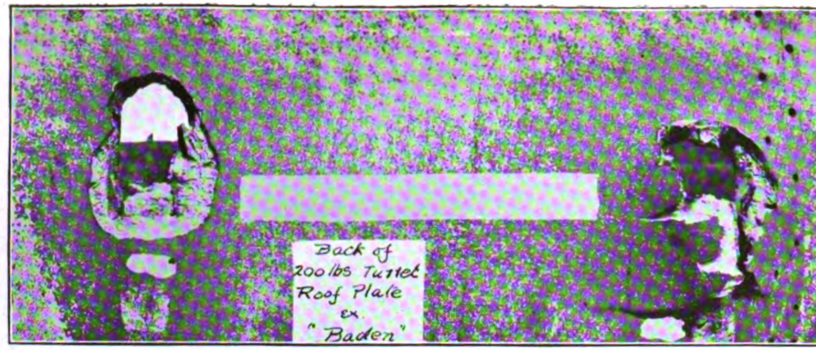


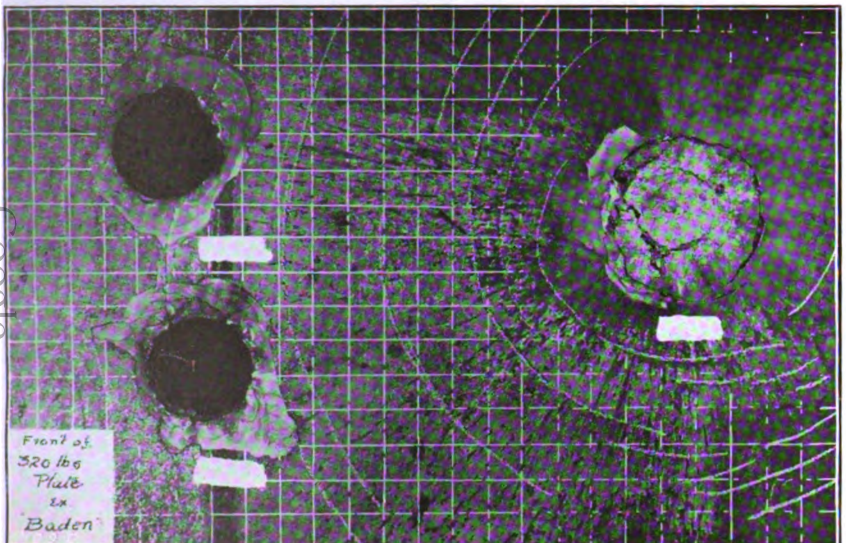

160-lb. per sq. ft. Turret-roof Plate : Limiting Velocity of Penetration less than 95·5 per cent. of British Plate.

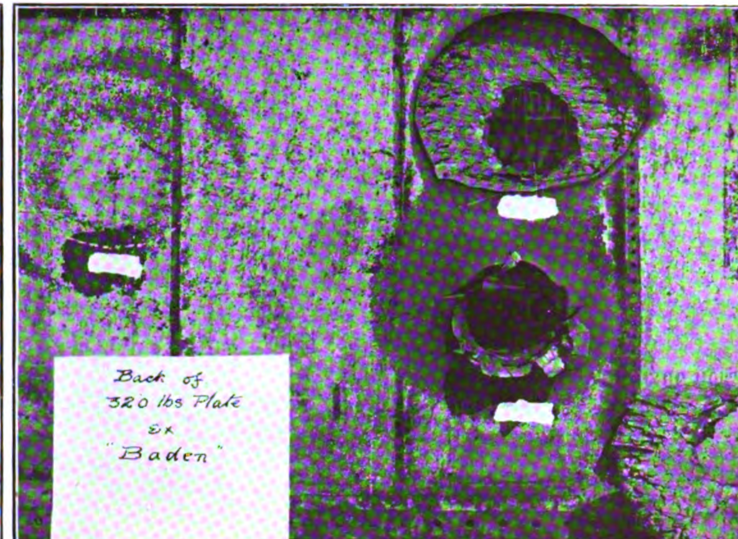
BRITISH TRIALS OF GERMAN ARMOUR PLATES.



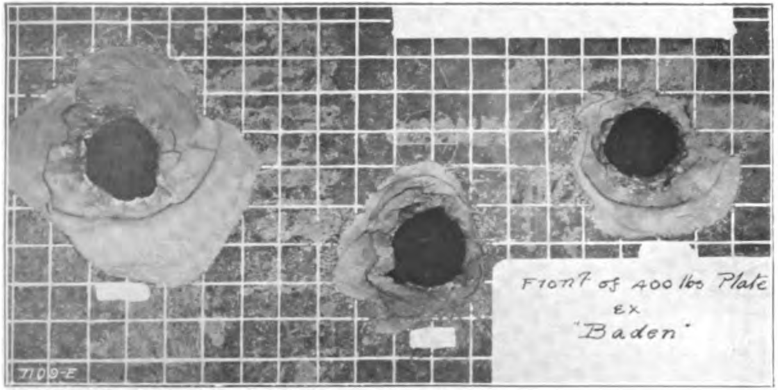

200 lb. per sq. ft. Turret-roof Plate: Limiting Velocity of Penetration less than 93·5 per cent. of British Plate.

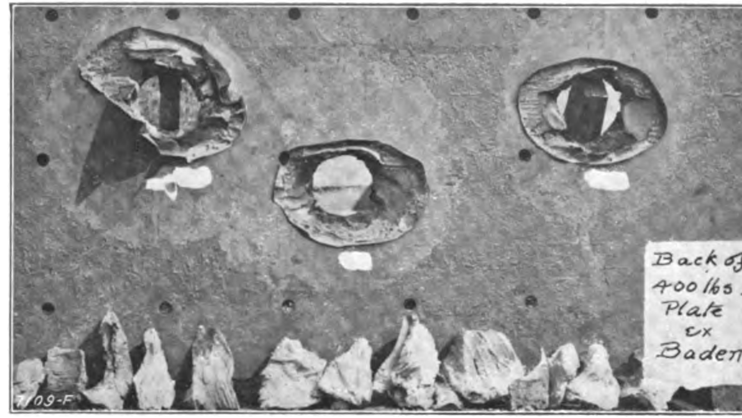


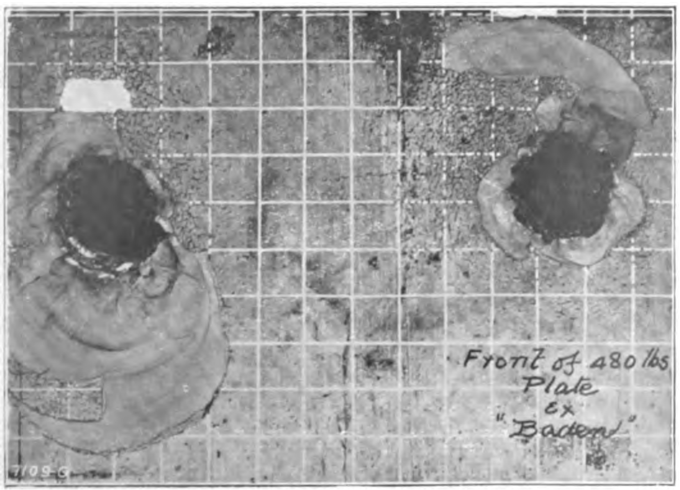

320-lb. per sq. ft. K.C. Plate: Limiting Velocity of Penetration 94 per cent. of British Plate.

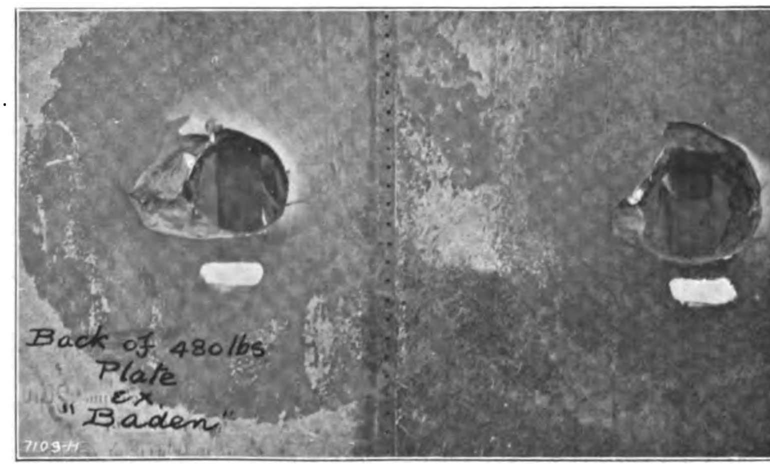
BRITISH TRIALS OF GERMAN ARMOUR PLATES.



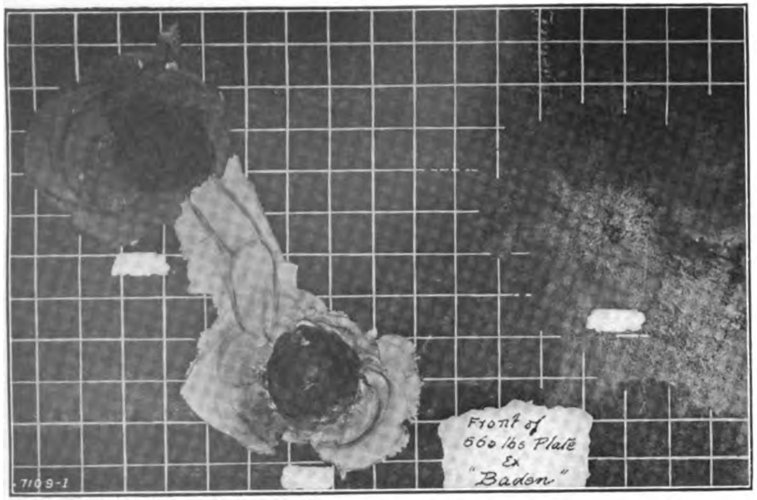

400-lb. per sq. ft. K.C. Plate: Limiting Velocity of Penetration less than 89·5 per cent. of British Plate.

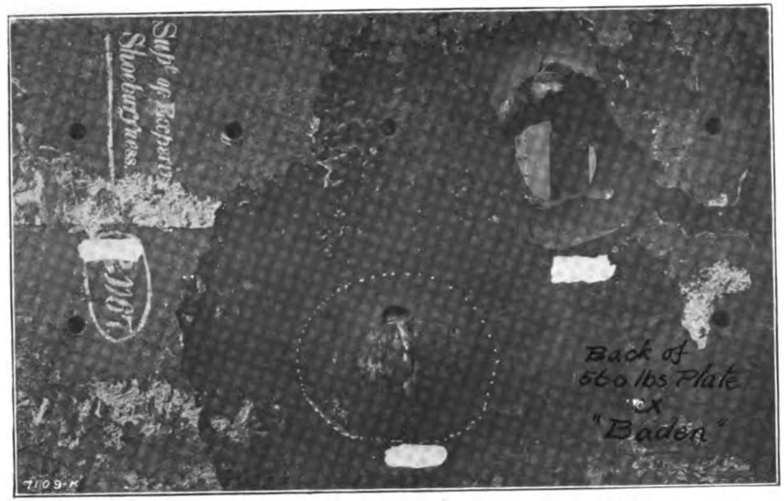



480-lb. per sq. ft. K.C. Plate: Limiting Velocity of Penetration less than 83·5 per cent. of British Plate

BRITISH TRIALS OF GERMAN ARMOUR PLATES.

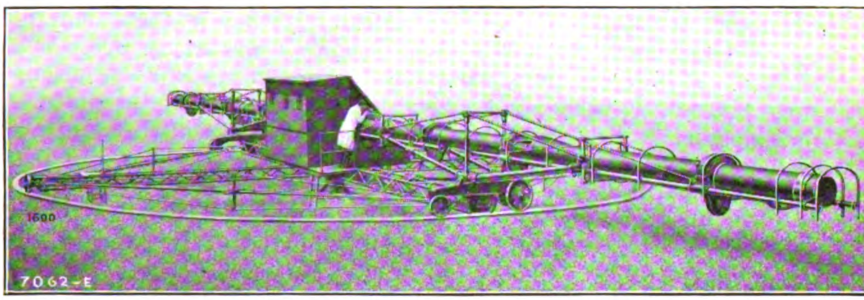



560-lb. per sq. ft. K.C. Plate: Limiting Velocity of Penetration 91·5 per cent. of British Plate.

BRITISH TRIALS OF GERMAN ARMOUR PLATES.

The first Barr and Stroud rangefinders adopted by the Admiralty had a base length of 4 ft. 6 in. and a magnifying power of about 24 diameters. At the present day the standard base length for the main armament gunnery purposes is about 30 ft., but the largest self-contained rangefinder constructed by Messrs. Barr & Stroud, Ltd., has a base length of 100 ft. This instrument is illustrated below. Although the base lengths of rangefinders have increased very greatly, it should be observed that the magnification has not increased, there being a limit determined by the quality of the atmosphere and of the optical materials. The increased accuracy necessitated by the desire for increased range of fire has been attained by an increase of base length, and, to some extent, as the result of experience and increased perfection of workmanship. The optical limitation above referred to naturally raises the question as to whether or not some method other than optical might be utilised for rangefinding. For example, it has been proposed to use two rangefinder stations situated at the end of as long a base as is obtainable on board ship, the stations being interconnected electrically




100-FEET BASE RANGEFINDER (COAST DEFENCE).
The man on platform, introduced for comparison, is using one of the smallest rangefinders.

or in other ways. It should be remembered that coincidence observations are by far the most accurate that are known. Further, a self-contained rangefinder has several very obvious advantages. Being self-contained, there is less chance of the rangefinder being directed upon a wrong target, as in the case of two-position installations where the danger of two operators working on different targets, or parts of the target, is very great indeed. Rapidity of observation, which is a particular feature of the self-contained rangefinder, is also of the greatest importance in an action. A two-position rangefinder has only the benefit of the long base in a direction normal to its base, whereas the full use of the base is obtained on all bearings in the case of the self-contained instrument.

## LENGTH OF BASE.

In the early stages of the war, as previously mentioned, the majority of the rangefinders in service had a base length of only 9 ft., notwithstanding the fact that rangefinders of much longer base were being

manufactured by Messrs. Barr & Stroud, Ltd., and that the need for longer-base instruments was fully recognised by responsible officers. The substitution of longer-base instruments could not always be readily effected in existing ships, and it was only in later construction, that had not advanced to too great an extent, that the rears of the gun turrets and the observation stations were designed to take rangefinders of 30-ft. base which the makers had been in a position to supply for some time previously. The question naturally arises as to whether or not even a 30-ft. base rangefinder is sufficiently long for modern gunnery requirements. To satisfy the requirements of the service, the rangefinder must be capable of measuring under ideal conditions a parallax angle of slightly less than half a second, equivalent to about one part in half a million. Under service conditions, a smaller accuracy of about one and a half seconds is to be expected, this parallax value being equivalent to 140 yards at a range of 15,000 yards, in the case of a 30-ft. base rangefinder. From the scientific point of view, it will be evident that the performance of even a 30-ft. base rangefinder is extraordinary, more particularly when it is considered that this accuracy is attained under conditions of the severest kind; in the excitement of an action when the ship is steaming at the highest speed and possibly being struck by enemy salvoes. However reluctant ship constructors are to make provision for still longer base rangefinders, it is to be hoped that future developments will be in this direction. From the fact that Messrs. Barr & Stroud, Ltd., have already constructed a coast defence rangefinder of 100-ft. base, the accuracy of which has proved to be even greater than was anticipated, it would appear that very considerable increases in the base length of naval rangefinders are practicable.

### Coincidence *v.* Stereoscopic Type.

Valuable experience regarding the use of rangefinders has been obtained during the recent war. The rangefinders installed in the British battleship squadrons were all of 9-ft. base and of the coincidence type. In the German Navy at the time of the action, the majority of the ships were provided with stereoscopic rangefinders of 3 metres base, i.e. about 9-ft. base. The Baden and the Bayern appear to have been fitted with rangefinders of 8·2 metres base, but neither of these ships took any part in the main action. It is understood that a 6-metre base coincidence rangefinder was installed on one of the turrets of the Derfflinger, which took part in the action. There has always been considerable divergence of opinion as to the relative merits of coincidence and stereoscopic rangefinders. The experience of the war, and information as to the behaviour of the German stereoscopic instruments, has been in no way unfavourable to the coincidence method. Indeed there is reason to believe that the objections of many German naval officers to the use of stereoscopic rangefinders were justified by the results of the action. It is much easier to train a coincidence observer than a stereoscopic one, and numbers of men are quite incapable of making satisfactory

stereoscopic observations. This applied to certain of the German naval officers who were unable to check the readings of their range-takers. Few gunnery officers care to be in the unpleasant position of being unable to check the work of those under their charge. It is understood that during the Battle of Jutland, in the heat of the action, particularly after the ships were hit by heavy salvoes, the nervous strain in the case of some of the stereoscopic observers was such that they lost their power of observation.

It has been claimed that stereoscopic rangefinders are particularly suitable for observations on very indistinct objects dimly visible through smoke or for observation upon a short length of mast appearing above a smoke cloud. This, however, does not appear to be the case to any marked extent, and this view is confirmed by the testimony of several responsible German officers. Stereoscopic rangefinders of base lengths up to 30 ft. have been constructed by Messrs. Barr & Stroud, Ltd.

## Transmission of Indicators.

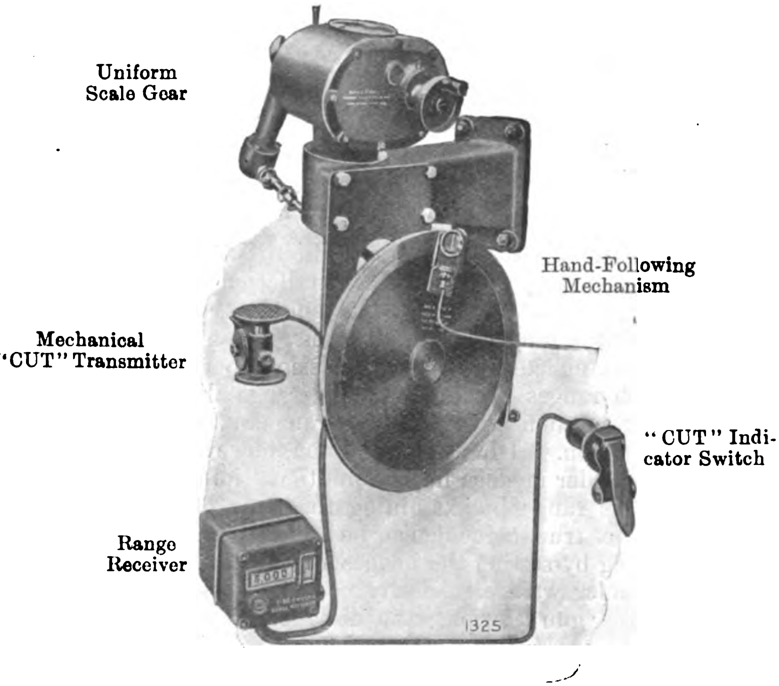
Reference has already been made in the 1913 edition of the "Annual" to the mountings and the installation of the rangefinders, to the use of self-contained adjusters, and to the apparatus for the transmission of the rangefinder indications. Considerable improvements have been effected in the transmission to the gun or torpedo stations of the ranges obtained by the rangetaker, the subject of automatic transmission direct from the rangefinder having been long under consideration. Direct transmission, however, has certain disadvantages. Under modern naval conditions the rangetaker usually "seeks" for his range by examining the state of alignment above and below the true coincidence position, finally obtaining an accurate reading by setting the images in the intermediate position. If the rangefinder were electrically connected *direct* to the range receivers at the gun stations, the dials of these receivers would follow every movement of the rangefinder working head, and the varying readings would give rise to uncertainty on the part of those reading the indications. Further, under these conditions, it would be necessary when a range was obtained for the rangetaker to refrain from moving the working head until all operators concerned had had sufficient time to note the range indications. There is some danger, in the heat of an action, that when the rangetaker has obtained the range he will not pause a sufficient time to ensure the range indications on the receivers being definitely noted. Indeed, it is highly inadvisable that such waiting periods on the part of the rangetaker should occur, having regard to the importance in an action of rapid and continuous rangetaking.

To obviate these difficulties, the range hand-following mechanism was introduced by Messrs. Barr & Stroud.

The reciprocal scale of the rangefinder is first converted by special gear, described later into a uniformly-divided range scale. The uniform range scale motion is mechanically transmitted to a hand-following mechanism, comprising an index travelling around a fixed uniform scale of ranges engraved round the periphery of a

circular dial. A second index is operated by the movement of a handle controlled by the hand-following operator whose duty it is to "follow" the movement of the first index. The same handle automatically operates a transmitter commutator electrically controlling the distant range receivers. A "cut" indicator, operated by the rangetaker, is provided at the dial centre of the hand-following mechanism and similar indicators, operated electrically by the hand-following operator, are also provided at each receiver to indicate when the reading transmitted is an actual range.

It will be seen that this method of transmission enables the rangetaker to pause but momentarily to signal "cut" when he has obtained a good range, and immediately to proceed with further observations. The hand-follower can set his index to the range, signal "cut" to the receivers, and leave his index at that range for some time until another range is obtained.




RANGE TRANSMISSION GEAR.

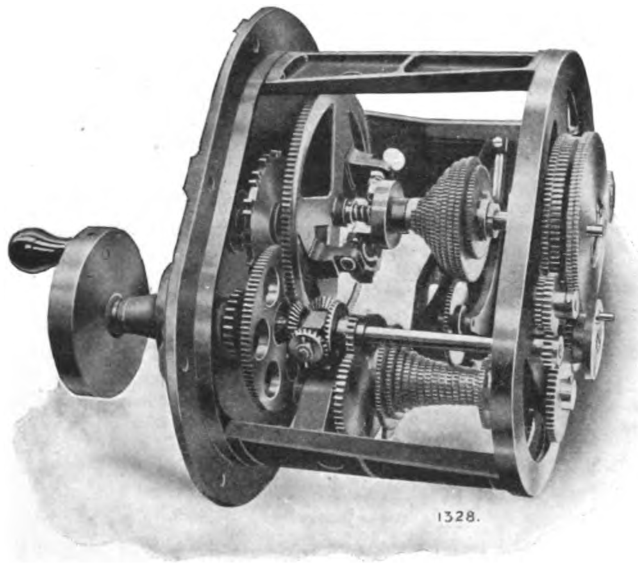
A typical installation of the apparatus, as now fitted to the majority of gunnery rangefinders, is illustrated above The rangefinder is connected by a coupling to the scale conversion gear, a view of which, with the cover removed, is given on the opposite page. The constantly varying ratio necessary for the conversion of the reciprocal scale motion into corresponding uniform scale motion is obtained by the combination with a differential of two helico-spiral gears, which gear with each other through the intermediary of an idle wheel. It is obviously impossible to transmit ranges up to infinity upon a uniform scale, and the gear is, therefore, designed to transmit correctly between certain limits, the higher range limit being ten times the lower limit in the case of the particular size of gear illustrated.

There are several minor, but none the less important, accessories to the rangefinder that have been introduced within recent years. Among these may be mentioned the desiccator apparatus by means of which the air in the interior of the instrument can be sufficiently dried and circulated even while ranges are being taken; and the air

and water blast for the end windows, whereby the windows can be kept clean and free from smoke, grit, etc., during an action.

### Rangefinders Against Aircraft.

Rangefinders for use against aircraft are now an important part of the equipment of the modern battleship. The Barr & Stroud instruments installed for this purpose during the war were of 2-metres base length, and were mounted to swing in a vertical plane upon a horizontal trunnion. The eyepiece is situated on the axis of the trunnion, thus enabling the rangetaker to make observations with comfort upon objects at practically all altitudes. The rangetaker




Range Scale Conversion Gear.

usually controls the instrument in azimuth, while it is controlled in elevation by a second observer who is provided with a prismatic telescope. The scale is read by a third observer. Mechanism associated with a pendulum is provided, which automatically determines the height of the target from the range and elevation.

As there are practical difficulties in the installation of such vertical-base rangefinders, especially when longer than 2 metres, anti-aircraft rangefinders similar to those used on land, having the usual horizontal base and provided with height scales, are now being considered.

### Instructional Gear.

The Barr & Stroud rangefinder instructional gear is now being installed in many ships for the training and practice of rangetakers. By its use rangetaking may be practised without reference to any

distant object, and the conditions prevailing when observations are taken in the ordinary way upon a moving target can be simulated. The whole transmission system from rangefinder to transmitting station and plotting board may be exercised, and the results at the plotting board may be checked with the ranges given on the range scale of the instructional gear. Systematic or accidental errors at every stage of transmission can, in this way, be discovered and investigated. A description of the apparatus follows :—

The gear consists of a shaft carrying at its ends two similar marks—which may be silhouettes of a warship—whose distance apart is approximately equal to the base length of the rangefinder. This shaft carrying the marks is set up at a short distance from the rangefinder with its axis parallel to the rangefinder axis. In the case of turret rangefinders, for instance, the gear is placed on the roof of the turret, and is so designed that it can easily be removed for stowage when not in use. If the distance between the two marks is exactly equal to the base length of the rangefinder, it is obvious that when the images of the silhouettes are in coincidence the rangefinder scale will indicate infinity; in other words, the lines of sight of the rangefinder will be parallel. Provision is made whereby one of the marks can be moved towards the other, thus causing the lines of sight to be no longer parallel. Each position of the moving mark corresponds to a definite range on the rangefinder scale. This range is indicated on a scale drum connected with the moving mark. By means of a small electric motor associated with variable speed mechanism, the moving mark can be made to travel at various appropriate constant speeds corresponding with various rates of change of range. Means are also provided for rocking the shaft on which the two marks are mounted in imitation of the roll of the ship and the period of the motion is capable of adjustment.

For the training of rangetakers below deck or ashore apart from the actual rangefinder installation, a small self-contained rangetaker tester has been introduced. The apparatus provides means for the training, practising, and testing of coincidence rangefinder observers on either stationary or moving targets. The operation of taking a range with a single observer rangefinder working upon the coincidence principle is simulated, but instead of readings of range being taken, the discrepancy in the setting of the cut from true coincidence is recorded upon a paper chart, which gives a permanent record of each setting made by the observer during the test. The apparatus is of considerable value not only in enabling the selection of suitable men for rangetaking to be easily carried out, but also when constantly used it engenders a healthy competitive spirit amongst the rangetakers, conducing to greater efficiency.

The Barr & Stroud unifocal periscopes and bifocal sky-searching periscopes for submarines embody some special features of interest. All optical adjustments such as change of power, focussing, and the interposition of fog and haze glasses, are carried out within the instrument itself, there being no necessity for the observer to remove his eye from the eyepiece. The introduction of focussing gear was itself an improvement of importance, as eyestrain was thereby obviated. In the bifocal periscopes, the sky-searching prism arrangement is such that a large angle of view is obtained with a comparatively small head. Self-contained range estimators are frequently provided. These are incorporated in the optical system within the periscope tube, and can be used without removing the eye from the eyepiece. By their use, the angle subtended at the periscope by either the length or the height of the enemy can be measured.

If the actual height of the enemy is known and the angle measured, the range can be readily deduced. Similarly if the length of the enemy is known, the estimator, when oriented through 90°, can also be used as an inclinometer, enabling the course of the enemy to be determined.

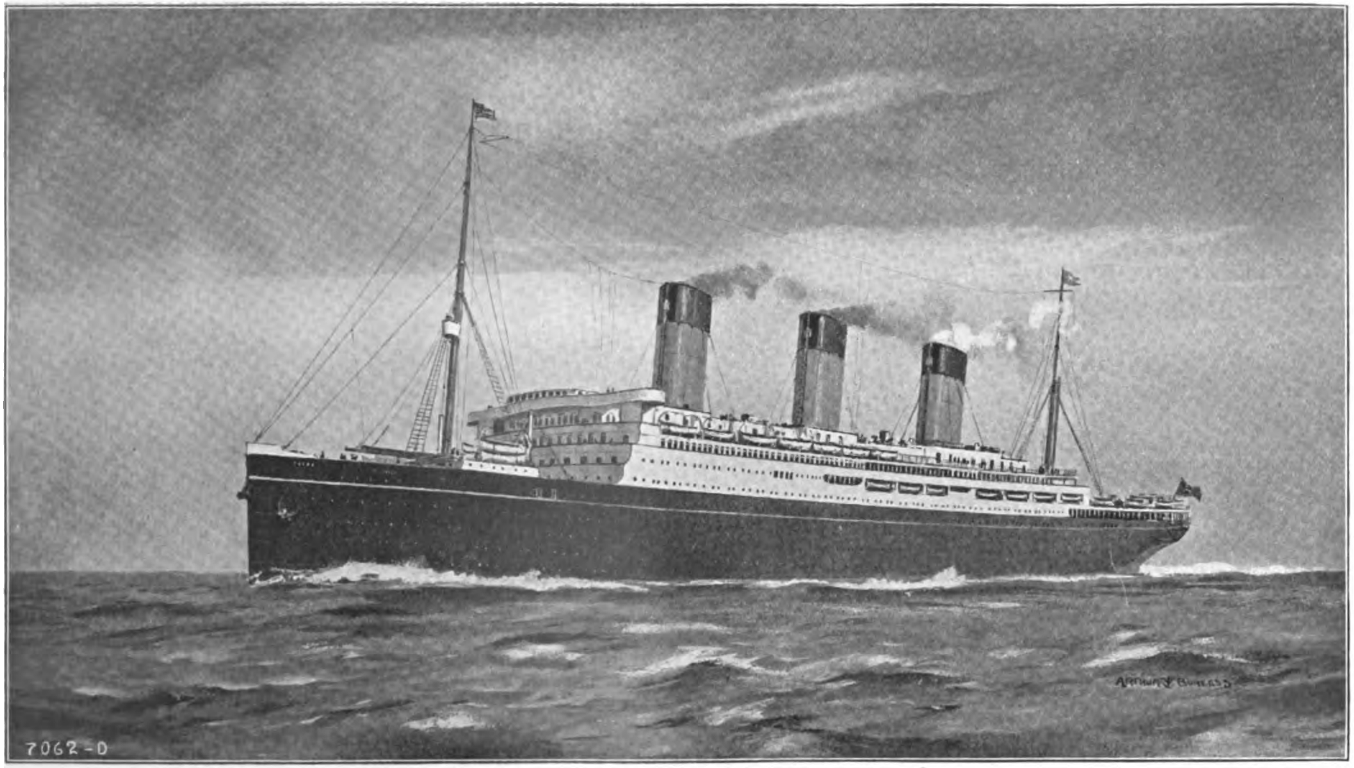
Vertical base periscope-rangefinders have been supplied by Messrs. Barr & Stroud, Ltd. These instruments, while performing the functions of a 30-ft. submarine periscope, can also be used for measuring ranges on the coincidence principle. The base length of the rangefinder is 3 ft. and it is disposed along the periscope tube at the top. The instruments suffice for general requirements, but for gunnery purposes a horizontal base rangefinder is considered to be essential.

For the testing of the depth and roll of a torpedo during trial, the Barr & Stroud torpedo depth and roll recorder has been developed. It is secured within the head of the torpedo and automatically records the variations in depth and the roll upon a time base. Depth is measured by the water pressure upon a plunger, the movement of which is communicated to a pencil moving over a travelling chart controlled by clockwork. Roll is measured by a pendulum, the movement of which is recorded by a second pencil moving over the same chart. The two records upon the chart are so arranged that a vertical line will show the depth and roll at any moment of the torpedo's travel. The clockwork mechanism is automatically started by the firing of the torpedo.

It may be mentioned that the designs adopted by the various Government Departments for their respective services have been in a large measure the result of competition between the designers of ordnance material associated with private firms and those of the various Government Departments, the designs being produced to meet the official conditions stipulated. This competition has provided the necessary stimulus to such excellence of design as has been attained. It may be said that this has applied to every department of armament production. It is undoubtedly true that but for the years of research and the foresight of the various ordnance manufacturers, and the preparations made by them to carry out work for our own and foreign Governments, the rapid increase in manufacture of armaments required to meet the national necessity during the late war, would not have been possible. From the record of past achievements, no hope can be entertained that the rich scientific and engineering attainments in all branches of industry would have been reached had they been under State Control, and it must be clear that this principle is especially true when it is applied to so specialised an industry as the design and manufacture of ordnance, projectiles, armour, and naval war material generally.

CHAS. N. ROBINSON.

# MERCHANT SHIPPING SECTION.




(*From a drawing by Arthur J. W. Burgess.*)

WHITE STAR LINER MAJESTIC (EX-BISMARCK).

**Length over all, 956 ft.; Depth from keel to boat-deck, 102 ft.; Breadth, 100 ft.; Gross tonnage, 56,000; Shaft horse-power, 100,000; Speed, 23 knots. Constructed by Messrs. Blohm & Voss, Hamburg.**

# CHAPTER I.

## THE WORLD'S MERCANTILE MARINE.

THE present position of world shipping is entirely without precedent, and consequently any attempt to estimate future demands for tonnage involves so many assumptions that it is impossible to arrive at a broad indication of the direction in which the maritime transportation of the world is tending.

For the first time in modern history, a war has been fought on such a gigantic scale as to suggest that an adequate merchant fleet is at least as important as the fighting Navy, with the consequence that every country with maritime aspirations has had its attention drawn, by the force of circumstances, to the value of a mercantile marine to act as auxiliary to the fighting Navy in time of war. This revived interest has been evidenced in practically every country engaged in the war, with the consequence that when the Armistice was concluded they all with one accord attempted to place their mercantile marines on such a footing that they would not be caught unprepared in the next war. Furthermore, this policy was pursued without regard to the economic conditions which would be experienced during the time of peace which must elapse before another war, and without sufficient regard to the efforts that were being, and would be made, to postpone another world war, if not for ever, at least for an appreciable period. Little account was also taken of the speculative character of shipping, and it was assumed that large profits were the rule rather than the exception.

It might be said in popular language that there was just such a race for position in regard to the possession of the maximum amount of merchant ship tonnage as there had been before the war in the case of naval armaments, and if the same forces had been at work properly to regulate the supply and demand of the world's shipping tonnage, there is no doubt that the shipping of most countries would not be in the deplorable state that exists at the present time.

During the discussion on a paper read by Mr. Maxwell Ballard before the North-East Coast Institution of Engineers and Shipbuilders at the end of last year, Mr. Ballard stated that "it does not appear logical to anticipate a lengthy period of trade depression to be near at hand, nor even that the existing artificial depression will be more than temporary. There are, indeed, already signs, so far as industrial unrest is concerned, of a tendency towards betterment generally." Those remarks were challenged by the writer, and the main points of his suggestions are contained in an article published in *Engineering* of February 11, 1921. It was pointed out from a study of the world's shipping statistics, that whereas the world tonnage in 1914 was of the order of 49,000,000 tons gross, yet although the world

possessed 51,000,000 tons gross somewhere about the middle of 1919, the demand for shipping was satisfied approximately at that time. The shipbuilding machine which was capable of producing about 3·33 million tons gross per annum in pre-war days, was turning out ships at that time at the rate of about 7·2 million tons, with the result that, from that time onwards, much more tonnage was created than could possibly be compensated for by any natural rate of depreciation or even by any wholesale scrapping of the old tonnage which had been maintained in service for war emergency purposes.

The position may perhaps be epitomised by saying that, whereas the world's demand for tonnage at the end of the war was very little more than that which existed in pre-war days, yet the world's shipbuilders could produce twice as much shipping after the war as before it. If it had been possible in some broad way to control the financial interests involved, it would have been desirable to have cut down the shipbuilding production as suddenly as possible, so as to reduce its output to one half by somewhere about the beginning to the middle of 1920.

## The Re-distribution of World Tonnage.

As an illustration of the result of the war on the re-distribution of world tonnage among the various maritime countries, it may be as well to quote the statistics given in the Appendix to Lloyd's Register for the period 1921–22 (which gives the statistics for the end of June, 1921), and to compare these with the figures given for June, 1914. This can be done with the aid of the following table:—

Sea-going Steel and Iron Steam Tonnage owned by the Principal Maritime Countries.

| Country. | June, 1914. | June, 1921. | Difference between 1921 and 1914. |
|---|---|---|---|
| | Tons gross. | Tons gross | Tons gross. |
| United Kingdom | 18,877,000 | 19,288,000 | + 411,000 |
| British Dominions | 1,407,000 | 1,950,000 | + 543,000 |
| America (United States) | 1,837,000 | 12,314,000 | + 10,477,000 |
| Austria-Hungary | 1,052,000 | Nil. | — |
| Denmark | 768,000 | 866,000 | + 98,000 |
| France | 1,918,000 | 3,046,000 | + 1,128,000 |
| Germany | 5,098,000 | 654,000 | – 4,444,000 |
| Greece | 820,000 | 576,000 | – 244,000 |
| Holland | 1,471,000 | 2,207,000 | + 736,000 |
| Italy | 1,428,000 | 2,378,000 | + 950,000 |
| Japan | 1,642,000 | 3,063,000 | + 1,421,000 |
| Norway | 1,923,000 | 2,285,000 | + 362,000 |
| Spain | 883,000 | 1,094,000 | + 211,000 |
| Sweden | 992,000 | 1,037,000 | + 45,000 |
| Total Abroad | 23,637,000 | 34,929,000 | + 11,292,000 |
| World's Total | 42,514,000 | 54,217,000 | + 11,703,000 |

The above table is confined to sea-going steel steam tonnage, which, after all in modern times, is practically all that need be considered, since the tonnage depending on sail power is not 5 per cent. of the total, and the 1¼ million tons of wooden steamers owned by the United States Shipping Board can be regarded as useless.

It will be observed that, as regards the total amount of gross tonnage registered in the United Kingdom, the figures are practically the same for the two periods mentioned, while for the whole of the British Empire the totals have increased by about 1 million tons, the respective figures being approximately 20 million tons in 1914, and 21 million tons in 1921.

In pre-war days, Germany occupied the second position in the world, with a total of about 5 million tons, which position is now occupied by the United States with a grand total of 12·3 million tons (excluding Great Lakes shipping), an increase of 10½ million tons during the war period.

In 1921 there is practically a tie between Japan and France, both of which countries possess tonnage slightly in excess of 3 million gross tons, and in both these countries the increase during the war period has been exceptional, being about 50 per cent. in the case of France and about 85 per cent. in the case of Japan.

The maritime fleets of Italy, Holland, and Scandinavia (Sweden, Norway, and Denmark) have all appreciably increased, the growth, being about 66 per cent., 50 per cent., and 14 per cent., respectively.

On the other side of the picture, the position of Germany has been reduced to the lowest of any country of importance, and nearly 90 per cent. of its tonnage has been surrendered to the Allied Powers.

The balance of power has changed as the result of the war in the manner indicated in the following table:—

PERCENTAGE OF THE WORLD'S TOTAL SEA-GOING STEEL AND IRON STEAM TONNAGE OWNED BY THE PRINCIPAL MARITIME COUNTRIES.

| Country. | June, 1914. | | June, 1921. | |
|---|---|---|---|---|
| | Tonnage owned in millions of tons. | Percentage of World's total. | Tonnage owned in millions of tons. | Percentage of World's total. |
| British Empire | 20·28 | 47·7 | 21·24 | 39·3 |
| United States | 1·84 | 4·3 | 12·31 | 22·7 |
| France | 1·92 | 4·5 | 3·05 | 5·6 |
| Germany | 5·10 | 12·0 | 0·65 | 1·2 |
| Greece | 0·82 | 1·9 | 0·58 | 1·1 |
| Holland | 1·47 | 3·5 | 2·21 | 4·1 |
| Italy | 1·43 | 3·4 | 2·38 | 4·4 |
| Japan | 1·64 | 3·9 | 3·06 | 5·6 |
| Spain | 0·88 | 2·1 | 1·09 | 2·0 |
| Scandinavia | 3·68 | 8·7 | 4·19 | 7·7 |
| Austria-Hungary | 1·05 | 2·5 | Nil. | Nil. |
| Rest of World | 2·40 | 5·6 | 3·46 | 6·4 |
| World's Total | 42·51 | | 54·22 | |

It will be seen that whereas in 1914 the United Kingdom owned nearly 44½ per cent. and the British Empire some 48 per cent. of the world's sea-going steel tonnage, yet these figures were reduced by June, 1921, to about 35½ per cent. and 39½ per cent. respectively, while, on the other hand, the United States percentage increased from 4·3 to 22·7.

### The Position of Germany.

The surplus in world tonnage is also being affected by the surrender of the German and Austrian tonnage to the Allies and its distribution among them, since Germany at least is making very strenuous endeavours to replace the surrendered vessels, which were mostly five years old, by new tonnage embodying the most modern developments in naval architecture and marine engineering. This policy of replacement is being supported by the German State to a considerable extent, and it was originally arranged that the Government should reimburse the shipowners who built vessels to replace those surrendered, by an amount varying from 75 to 90 per cent. of the total cost of the new tonnage, the actual percentage depending on the power and type of the vessel. This subsidy has since been modified, to some extent, by the acceptance of a gross sum which is to be paid by the Government to shipowners in settlement of their claims for indemnity.

The Treaty of Versailles seems to have had as its guide the policy that control should be exercised over German shipping for a period of five years, apparently anticipating that the Germans would make strenuous endeavours to replace their tonnage, and that there would be a shortage in the world supply during that period. As events have transpired, it would apparently have been better to have placed the surrendered vessels in an Allied pool for the period of five years, to have allotted to Germany on charter from that pool the tonnage necessary to carry on her overseas trade, and to have forbidden her to build any new tonnage during that period, at the end of which the old German vessels might have been returned to her. This policy would at least have been effective in the control of German sea activities, and at the same time would not have added to the world tonnage an amount of shipping which was not likely to be, and which experience has shown was not, necessary for the world's shipping demand.

There is no doubt that, during the last twelve months, the German shipbuilding yards have been very active, as is witnessed by the fact that dividends paid by them are from 50 to 100 per cent. higher than last year. A great many of the restrictions arising from the war have been overcome, and it is understood that piece work, with corresponding prices, was reintroduced at the end of 1918, causing a rapid increase in production.

The London Conference of May, 1920, decided that, of the tonnage then under construction in Germany, about 250,000 tons should be delivered to the allied Reparation Commission, the remaining 100,000 tons being allowed to belong to Germany. It does not appear

probable that the Allies will exercise their right to the 200,000 tons yearly to which they are entitled under the terms of the Peace Treaty for the five years subsequent thereto, and this opinion is confirmed by the fact that some of the ex-German surrendered vessels have been re-sold to that country, as the international market could not absorb them. Further, it is considered that the abstraction of 200,000 tons yearly from the shipbuilding output of Germany would not seriously hamper that country in the replacement of its mercantile marine. Big amalgamations of capital have taken place between shipping interests, coal companies, steel works, and shipbuilding yards, which will make Germany's position in relation to international competition a very favourable one, while the yards are maintained with a constant supply of work for the next three or four years owing to the operation of the Government subsidy. Further, these favourable circumstances will be emphasised when the new vessels come into commission, as they will be of the latest type, suitable to the redistribution of the world's trade, and they will be in competition with the much older fleets of the rest of the world, a position which is certainly likely to be maintained for the average life of a new ship, say for another fifteen years.

It is understood that the terms of the German subsidy are that 12 milliards of marks (£50,000,000) are to be set aside as compensation to shipowners who lost their vessels as a result of the war, or who were compelled to surrender them, on condition that 90 per cent. of this amount shall be spent in Germany.

## Laid-up Tonnage.

The causes already described, coupled with the high prices that have to be paid for new tonnage under present wage conditions and restricted hours of labour, have prohibited shipowners from replacing their old vessels by new tonnage. In addition, the paralysis of depression which has overtaken industry owing to the failure of international credit and the uncertainty of legislation and taxation, extended at a very early stage to the shipbuilding industry, which is generally regarded as the key index to the state of world trade. As a consequence, the financial condition of the shipping industry was so seriously affected that it became necessary to lay up an enormous amount of tonnage at the beginning of this year. The slump which occurred, developed with abnormal rapidity, and from this circumstance it appears probable that the world's demand for shipping to-day is by no means as much as it was in 1914, and that the new tonnage which has been built during the war, and subsequent thereto, is less than the amount of tonnage at present laid up.

It was estimated in June of this year, that of the 54 million tons of seagoing steel steam tonnage, something like 12 millions, or say 20 per cent., was laid up in some form or another, to say nothing of the greater part of the 2 million tons of wood and composite steam vessels. As some evidence of the depression, the position of the United States Shipping Board may be quoted. The latest figures to hand indicate that, out of a total of 12 million odd tons gross of seagoing steel steam tonnage possessed by that body, some 733 ships

aggregating over 3 million tons gross were laid up on May 7 of this year. It is also stated that there were about that time some 55 per cent. of the U.S.S.B. steel vessels idle, while in addition 300 wooden vessels were laid up and were in such a condition that it was doubtful if they could ever again be taken into service. Beyond this it was also stated that a further million tons gross of privately-owned tonnage were laid up in United States ports, making a total for the country of roughly one-third of its sea-going tonnage.

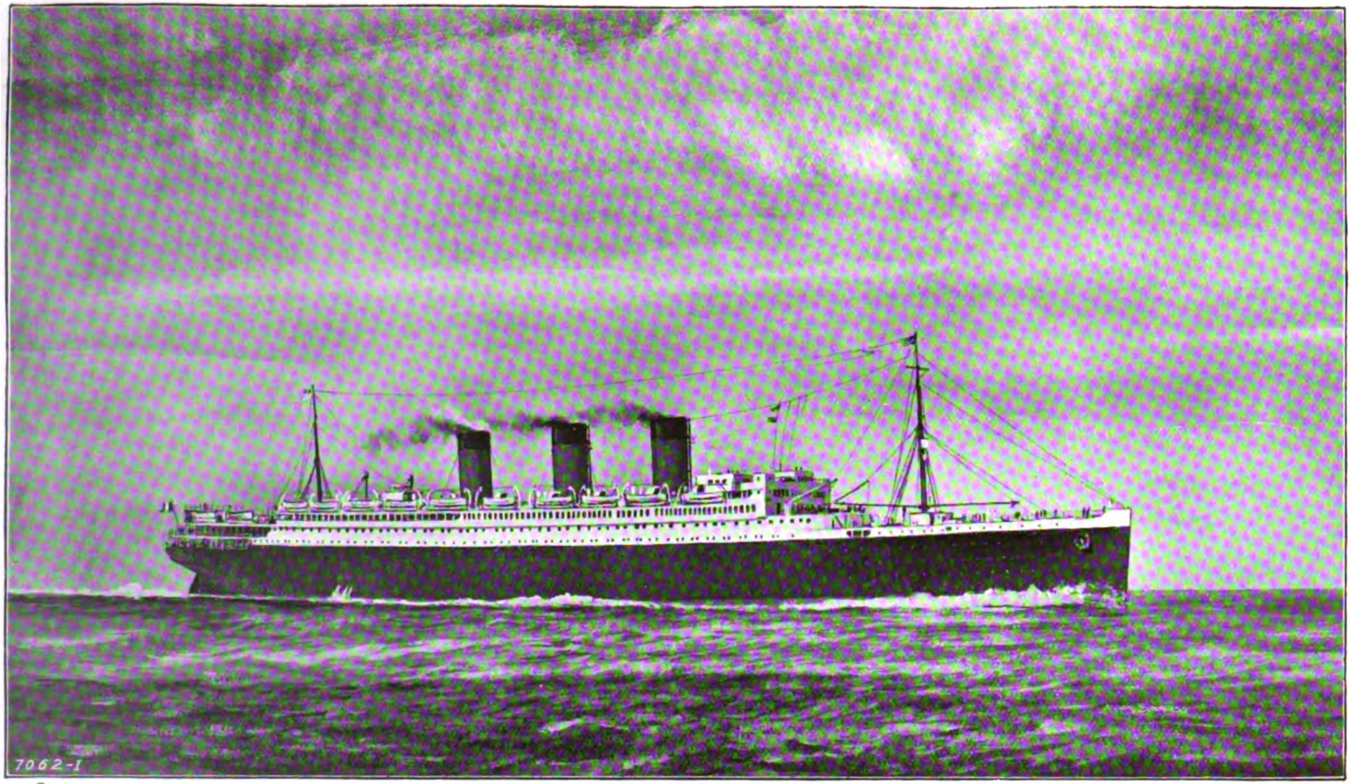
The position of the United Kingdom was rather more complex owing to the coal strike and the consequent want of coal both for bunkers and for export purposes, and, from the various statements made, it does not appear unlikely that during the month of June, 1921, some 4 million tons gross were laid up for some reason or other. It would appear also that at least a million tons of this 4 millions were laid up owing to causes arising directly, or indirectly, from the miners' strike; but even allowing for such an amount, it is a calamitous condition when approximately 15 per cent. of the merchant fleet of Great Britain, the freight-carrier of the world, is laid up by reason of trade depression and industrial disputes.

Taking these two examples as typical of the world demand for tonnage, it does not appear at all unreasonable to say that some 12 million gross tons of shipping, or about 20 per cent. of the world's seagoing steam vessels, are not wanted at the present time. This process of laying up is by no means a cheap one, since the maintenance of the vessels has still to be provided for, and it has been stated that, under the most economical circumstances, a charge of at least £10 a day is incurred for a 6,000 tons d.w. steamer, without making any allowance for depreciation or for insurance.

This excess of tonnage further accentuates the depression due to high cost in the shipbuilding world, since before shipbuilding prospects are likely to improve, a good proportion of this surplus will have to be profitably employed, after making due allowance for the fact that, owing to the use of all kinds and ages of vessels during the war, the average age of some of the older mercantile navies of the world must be considerably greater than it was in pre-war days, and there is now no possibility of disposing of old tonnage in the same manner as was commonly followed in pre-war days. It seems, therefore, as has been stated by many shipbuilders, that the prospect for a year or so is by no means rosy and is complicated by the fact, already mentioned in another connection, that the potentiality of ship production of the world to-day is approximately twice what it was before the war.

## The United States Shipping Board.

The position of the United States Shipping Board has been receiving considerable attention in America, and the outspoken utterances of the new Chairman, Mr. Albert D. Lasker, have given rise to a large amount of discussion in shipping circles. It would appear that the attitude of the body (which was re-constituted at the beginning of June) to the most difficult problem which confronts it




*(From a drawing by Arthur J. W. Burgess.)*

FRENCH LINER PARIS, FOR THE COMPAGNIE GÉNÉRALE TRANSATLANTIQUE.

Built and engined by the Société des Chantier et Ateliers de Saint-Nazaire.

*(For particulars see p. 427.)*

is to be essentially businesslike, and it may therefore be of interest to give a short description of its constitution.

Mr. Albert D. Lasker, the Chairman of the Board, is a Chicago business man, well known in the advertising world and as a stock-holder in numerous enterprises. He appears to have a big business reputation, but, so far as is known, has not previously had any direct experience in shipping affairs. Mr. T. V. O'Connor, of New York, is the Labour representative on the Board and is the President of the Long-shoremen's Union. Ex-Senator George E. Chamberlain was formerly a member of the Senate Committee on Commerce, and he has taken an active part in formulating most of the shipping policies of Congress. Mr. Edward C. Plummer, of Maine, is the attorney for the Atlantic Carriers' Association, and has been to sea before the mast. Mr. Meyer Lissner is an attorney of California, and his appointment is considered to be political, while Mr. Frederick I. Thompson, of Alabama, and Admiral William Benson, of Georgia, were originally nominated to the Board by President Wilson.

The statements which have been issued, suggest that the policy of the Board is to procure the speedy operation of the dormant provisions of the Merchant Marine Act, 1920, many sections of which have not yet been put into operation. The Board apparently intends to liquidate, in every possible way, the Government interests in shipping by transfer to private ownership, and, for that purpose, is prepared to face a drastic reduction in the price of tonnage, say, from the original figure of 165 to 185 dollars per ton deadweight down to as low as 40-50 dollars per ton.

The whole personnel of the Board is to be reorganised and the shipping lines which have been started from the United States to various world ports, and which now all show a loss, are to be carefully examined and re-considered. What is to happen to the 300 wooden ships? Will they be either destroyed, sold as scrap, or still carried on by the Government? The Senate decided early in the summer of 1921, that all these vessels were to be disposed of in some way or another by October 1.

The various agreements entered into between the Hamburg-America Line and the United American Line and between the U.S. Mail Steamship Co. and the North-German Lloyd, are to be investigated, as these understandings have never as yet received the approval of the Government, and the contract between the International Mercantile Marine Co. and the British Government is also to be examined. The Board also propose to consider the question of preferential railroad rates for exports and imports which are carried in vessels of the U.S. Registry.

The financial position of the Board has been the subject of considerable comment. Mr. Charles M. Schwab, who was formerly director of the Emergency Fleet Corporation, has declared that an amortisation of 2,500 million dollars (£600,000,000) on the fleet of the Shipping Board would be justified and might be charged off as a war debt, the ships being realised at any reasonable price obtainable from private operators. He has also stated that the present fleet does not constitute a mercantile marine and that the ships were not of the desired types, nor were they economical in operation.

Mr. Lasker's statement on assuming duties as President of the Board was that—"America's shipping business to-day is the most colossal commercial wreck the world has ever seen, and the financial backing of the Government alone prevents it being the greatest bankruptcy ever recorded." It was stated that there was in June an outstanding claim of over 65 millions sterling against the Board under various contracts, and that the monthly working deficit was nearly 4 million pounds, not including the amounts arising from depreciation, interest and sinking fund, and probably insurance. It was further estimated that the loss through deterioration of the vessels under the control of the Board amounted to 36 million pounds sterling per annum, while the Commissioner of Navigation in his report for June, 1920, stated that if interest on the money raised by loans were taken at 5 per cent. and if the contributions to the sinking fund be rated at 2½ per cent., and the rate of depreciation allowed for statutory purposes be taken at 5 per cent., the amount to be paid in taxes would amount to 375 million dollars per annum (£95,000,000). It would, therefore, appear that under present conditions the amount of subsidy which has to be paid by the Government to the Shipping Board must be somewhere of the order of between 100 and 150 million pounds sterling per annum.

## THE WORLD'S SHIPBUILDING.

Prior to the war, the greatest tonnage output in all the shipyards of the world occurred in the year 1913, when 3·33 million gross tons of merchant vessels over 100 tons gross were launched. The following table gives the distribution of the tonnage building in the various maritime countries for the calendar years 1913, 1919, and 1920:—

WORLD'S SHIPBUILDING, IN MILLIONS OF GROSS TONS.

| Country. | 1913. | 1919. | 1920. |
|---|---|---|---|
| United Kingdom | 1·932 | 1·620 | 2·056 |
| British Dominions | 0·027* | 0·298 | 0·174 |
| British Empire | 1·959* | 1·918 | 2·230 |
| Germany | 0·465 | ? | ? |
| United States | 0·228† | 3·040† | 2·349† |
| France | 0·176 | 0·033 | 0·093 |
| Holland | 0·104 | 0·137 | 0·183 |
| Japan | 0·064 | 0·612 | 0·457 |
| Austria-Hungary | 0·062 | ? | ? |
| Italy | 0·050 | 0·083 | 0·133 |
| Scandinavia | 0·110 | 0·147 | 0·164 |
| Other Countries | 0·043 | 0·079 | 0·096 |
| World's Total | 3·261*† | 6·049†‡ | 5·705†‡ |

* Excludes Great Lakes Canadian Vessels.
† Excludes Wooden Vessels, and American Great Lakes tonnage.
‡ Does not include Germany and Austria-Hungary.

A rough comparison will indicate that, as mentioned above, the shipbuilding capacity of the world is roughly twice that possessed in 1914, and that the reduction in shipbuilding in 1920 was almost entirely due to the cessation of production of wooden steamers in the United States, the output of this type of vessel having been nearly one million gross tons in 1918 and over half a million tons in 1919. Apart from this reduction, the shipbuilding effort in 1920 was universally greater than in 1919.

It was becoming apparent, however, by the end of 1920 that an enormous depression was before the industry, due to the great fall in the international values of ships consequent on the surplus tonnage in existence, and although the amount of ships under construction apparently did not rapidly decrease, yet construction was being abandoned or postponed *sine die*, with the consequence that to-day the statistics of tonnage under construction do not give the same index of productive effort as was the case when economic conditions were being satisfied.

It is also fairly evident that the relation of rate of production of ships to total amount under construction was changing for other reasons, not directly connected with the decrease in demand for

RELATION BETWEEN SHIPBUILDING OUTPUT AND TONNAGE ON THE STOCKS.

| Country. | 1913. | | 1920. | |
|---|---|---|---|---|
| | Tonnage under construction in millions of gross tons. | Annual Output in millions of gross tons. | Tonnage under construction in millions of gross tons. | Annual Output in millions of gross tons. |
| United Kingdom . . . | 1·957 | | 2·994 | |
| British Dominions (including Great Lakes) . . | 0·039 | | 0·251 | |
| British Empire . . . | 1·996 | 1·981 | 3·245 | 2·260 |
| Germany . . . . . . | 0·545 | 0·465 | ? | ? |
| United States (including Great Lakes) . . . | 0·148 | 0·276 | 2·967 | 2·477 |
| France . . . . . . . | 0·229 | 0·176 | 0·217 | 0·093 |
| Holland . . . . . . | 0·127 | 0·104 | 0·328 | 0·183 |
| Japan . . . . . . . | 0·048 | 0·064 | 0·309 | 0·457 |
| Austria-Hungary . . . | 0·063 | 0·062 | ? | ? |
| Italy . . . . . . . | 0·054 | 0·050 | 0·315 | 0·133 |
| Scandinavia . . . . | 0·086 | 0·110 | 0·304 | 0·164 |
| Other Countries . . . | 0·035 | 0·043 | 0·176 | 0·095 |
| Totals (including Great Lakes) . . . . . | 3·331 | 3·333 | 7·861* | 5·862* |

tonnage. This point is well illustrated by the above table, which shows, for various countries, the relations between outputs in 1913 and 1920 and the tonnage under construction at the beginning of each of those years.

* Excluding Germany and Austria-Hungary.

It will be seen that, for the whole world, the amount of tonnage produced in 1913 was practically identical with the quantity under construction on January 1st of that year, whereas the corresponding figures in 1920 indicate that the output was not 75 per cent. of the total on the stocks at the commencement of that period. This may, to some extent, be explained by the fact that ships of the average size built in 1913 took exactly a year to complete, whereas in 1920, owing to a redistribution of trading arrangements, larger vessels were being constructed, a point which requires further examination.

The only countries which before the war had a high relation of output to tonnage on the stocks were the United States and Japan, and it will be seen that in 1920 this relation was still maintained, although not to the same extent by the United States as by Japan, which alone achieved as good a performance in 1920 as in 1913,

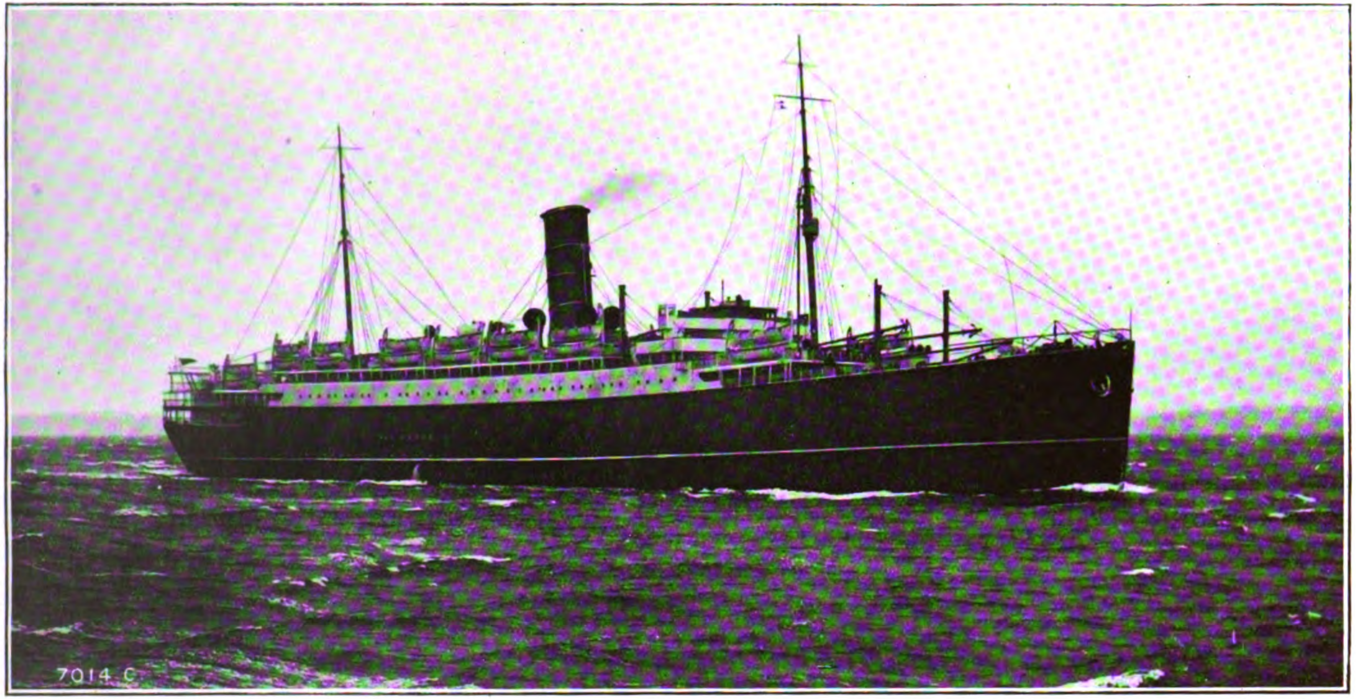
The falling off in relative productivity amounts to about 30 per cent. for the British Empire, over 15 per cent. for the United States, and in many other countries approximates to 50 per cent., which in these latter cases may, perhaps, be due to a large growth in shipbuilding facilities without a corresponding increase in the availability of suitable labour.

As a further indication of the shipbuilding position, it is of interest to refer to the statistics given in the Quarterly Shipbuilding Returns issued by Lloyd's Register, which give for the United Kingdom the vessels commenced and launched during the quarter. In the return issued at the end of June, 1921, particular attention was drawn to both the points mentioned in regard to delays in construction and decrease in the amount of tonnage commenced. It was stated that out of a total tonnage under construction at the end of June in the United Kingdom of over 3½ million gross tons, work had been suspended on nearly ¾ million tons and the tonnage of which the completion was postponed, principally on account of the joiners' strike and the miners' dispute, was estimated at nearly 450,000 tons. The amount of tonnage actually in hand was probably only about 2,350,000 tons out of the total record of 3½ millions, giving further indication of the decrease of performance in post-war times.

Similar statistics for the world are not fully available, but an estimate has been made which may, perhaps, be of use to the industry as some guide in the regulation of the extremely difficult circumstances which have to be faced.

The table on page 209 shows approximately, for the past two years, the tonnage under construction and the amounts launched and commenced for each quarter, both for the United Kingdom and the other countries of the world.

An analysis of this table supports certain important conclusions. It may be said that roughly five times the output of the first quarter for the United Kingdom, added to four times the similar figure for other countries, should give a close approximation to the annual world production of merchant ships. If this process be applied to the year 1920, the estimated production of tonnage would be 5·8 million tons, whereas the actual figure was 5·862.




PASSENGER STEAMER CAMERONIA, FOR THE ANCHOR-CUNARD FLEET.

Built and engined by Messrs. William Beardmore & Co., Ltd., Dalmuir, N.B.

Shipbuilding, in Millions of Gross Tons.

| Quarter ended. | United Kingdom. | | | Other Countries. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| | Under construction. | Commenced. | Launched. | Under construction. | Commenced. | Launched. | Under construction. | Commenced. | Launched. |
| Sept. 30, 1919 | 2·317 | — | 0·416 | 5·232 | — | 1·371 | 8·049 | — | 1·787 |
| Dec. 31, 1919 | 2·994 | 0·604 | 0·459 | 4·867 | 1·150 | 1·582 | 7·861 | 1·754 | 2·041 |
| Mar. 31, 1920 | 3·394 | 0·708 | 0·454 | 4·548 | 1·000 | 0·882 | 7·942 | 1·708 | 1·336 |
| June 30, 1920 | 3·578 | 0·588 | 0·523 | 4·143 | 0·796 | 1·022 | 7·721 | 1·384 | 1·545 |
| Sept. 30, 1920 | 3·731 | 0·594 | 0·483 | 3·834 | 0·788 | 1·005 | 7·565 | 1·382 | 1·488 |
| Dec. 31, 1920 | 3·709 | 0·506 | 0·580 | 3·471 | 0·720 | 0·897 | 7·180 | 1·226 | 1·477 |
| Mar. 31, 1921 | 3·799 | 0·393 | 0·433 | 3·288 | 0·462 | 0·622 | 7·087 | 0·855 | 1·055 |
| June 30, 1921 | 3·530 | 0·069 | 0·321 | 2·669 | 0·178 | 0 686 | 6·199 | 0·247 | 1·007 |

According to this conception, the annual output of ships for the year 1921 might be expected to be about 4½ million tons, but as the production in the United Kingdom in the second quarter was very much less than that of the first quarter, it appears likely that the output for this country will not exceed about 1·5 million tons, and that of the world will consequently be reduced to about 4 million tons.

The most serious factor is the small amount of tonnage which was put in hand in the second quarter of this year (aggregating only some 250,000 tons) which would seem to indicate, at the present rate of construction, that the world production of new ships would fall as low as, perhaps, 1,000,000 gross tons per annum at some period of next year, a position which, according to the Annual Summary of World Shipbuilding of Lloyd's Register, has only once occurred (in 1893) since the publication of these statistics was commenced in 1892.

## Increase in the Size of Ship Units.

Before the war, it was generally considered that the largest size of tramp steamer for economical operation was somewhere about 5,000 tons gross, or 8,000 tons deadweight, but a study of the relative compositions of mercantile fleets leads to the conclusion that war experience has fostered a demand for increased size which has, perhaps, also been furthered by the consolidation of certain former tramp services into cargo-liner routes.

The relative pre-war and post-war positions are, perhaps, best crystallised by considering three broad divisions of sea-going tonnage. It is now commonly accepted that the gross tonnage of 1,600 (or net tonnage of 1,000) roughly divides the vessels of the United Kingdom between foreign-going ships and those of the home and coasting trades, and while this figure may be the more exact, it is simpler for use to place the dividing line at 1,500 tons gross; the upper limit of the lowest of the three groups may conveniently be taken as 5,000 tons gross, the size of the largest tramp steamers in 1913. The second group should comprise the cargo liners and passenger vessels, the main earnings of which are dependent on their cargo-carrying capacity;

this group may conveniently be said to comprise vessels of from 5000 to 10,000 tons gross. The third group naturally comprises the big passenger liners and large bulk carriers, ranging from 10,000 tons to the huge tonnages of the Aquitania, Olympic, and other vessels of that order.

THE SIZE OF SHIP UNITS.

The approximate gross tonnage of the various larger types of steam vessels owned in the world, in millions of tons.

| Divisions of tonnage. | British Empire. | | U.S.A. (sea-going only). | | Japan. | | Other Countries. | | Totals.* | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1914. | 1921. | 1914. | 1921. | 1914 | 1921. | 1914. | 1921. | 1914. | 1921. |
| 1,500— 5,000 | 11·508 | 7·788 | 1·019 | 4·780 | 1·042 | 1·272 | 9·916 | 8·441 | 23·485 | 22·280 |
| 5,000—10,000 | 5·338 | 8·802 | 0·557 | 7·513 | 0·403 | 1·305 | 4·198 | 5·290 | 10·496 | 22·910 |
| 10,000 and above . | 1·983 | 2·701 | 0·141 | 0·998 | 0·086 | 0·100 | 1·222 | 0·791 | 3·432 | 4·590 |
| Totals . | 18·829 | 19·291 | 1·717 | 13·291 | 1·531 | 2·677 | 15·336 | 14·522 | 37·413 | 49·780 |

The above table shows more clearly than was to be expected the great change in size of tonnage brought about by the shipbuilding programmes of the last seven years. There is practically the same overseas tonnage in the world below 5,000 tons to-day as there was before the war, and the effect of the submarine campaign is shown in the great reduction in tramp tonnage possessed by the British Empire in 1921 as compared with 1914.

It is also to be noted that while the very large steamer tonnage has appreciably grown, yet practically the whole of the increase of 12 million tons in the world's merchant fleet has occurred in tonnages between 5,000 and 10,000 tons gross, vessels most suitable for cargo liners and small passenger vessels.

The British Empire tonnage has remained practically stationary, the losses in tramp steamers being compensated for by a growth of 50 per cent. in cargo liners, and an appreciable increase in large vessels. Japan has also steadily increased her fleet, almost entirely in the cargo-liner group.

It is the United States, however, which shows the most remarkable increase in every grade, and it will be observed that the war productivity for Allied purposes has placed that country almost on an equality with the British Empire in the 5,000 to 10,000 ton group.

## MOTOR VESSELS AND OIL FUEL.

The depression in freights and increased costs of operation have drawn marked attention to the economies that may be effected by

* Excludes American Great Lakes vessels, and vessels owned in the Philippine Islands.

the substitution of oil for coal as fuel for the generation of the propulsive power of vessels.

Other things being equal, one ton of oil fuel utilised in Diesel engines drives a vessel three times as far as one ton of coal burnt in the ordinary way under boilers, while if oil be used as fuel with water-tube boilers and geared-turbine engines, the arrangement is twice as efficient as when coal is the source of energy. Besides this increased efficiency of power production, there are other advantages to be derived owing to the ease of bunkering, the avoidance of trimming at sea, and the reduction of personnel for firing and supervision; while to some extent there may be a saving in weight (including fuel for the voyage) and a gain in space available for cargo, since the oil fuel can be carried in spaces, such as double bottoms, which cannot be used either for coal or cargo.

It is believed that recent experience has clearly indicated that Diesel-engined ships can be operated under present conditions with reasonable profit at a time when a large proportion of the world's tonnage has had to be temporarily laid aside, and there appears to be no doubt that, in view of the mechanical and economical advantages in the use of oil as fuel, a considerable proportion of the replace tonnage of the near future will be adapted for the new fuel.

The problems to be faced are not so much dependent on mechanical developments as on the amount of oil which is likely to be available at a reasonable cost for marine purposes and on the distribution of supply to any part of the world, observing that oil of a higher quality is required for Diesel engines than for boiler fuel.

It might be said, at the present time, that the demands for oil for power production appear to arise to a much greater extent from internal land requirements than from oversea adventure. The great development in the use of road motor transport in the United States and the United Kingdom, coupled with the extraordinary flexibility of such services, suggests that the direction in which inland communications is trending is towards road rather than rail service, certainly within a radius of 100 miles of large centres. And whereas the last century might be termed the age of railways, the first part of this century may later become known as the era of roads.

As evidence of this tendency, a Bulletin of the Geological Survey of the United States observes that, in the month of January, 1921, 38·3 million barrels of oil were produced in the country and 13·2 million barrels imported, making a total demand of 51·5 million barrels (or about 7·7 million tons) for the month, equivalent to about 92·5 million tons a year. It was also estimated, for the same month, that the domestic consumption for the United States was nearly 50 million barrels, which at the same rate would amount to about 90 million tons per annum.

The approximate world production of oil in 1920 was about 105 million tons, and it will be apparent, therefore, that the inland and maritime demands for oil in the United States were considerably in excess of its oil production and required somewhere approaching 90 per cent. of the world's supply. There appears little doubt that there are vast quantities of oil scattered all over the world, but the

question to be faced is whether the internal demands for oil fuel will not rise at a more rapid rate than that at which new services of supply can be developed. It may, therefore, conceivably happen that the domestic demand for oil may dominate the international price and the shipowner be compelled to use coal as being less costly for maritime purposes.

In addition, it is not to be forgotten that the world's supply of coal is at least six times as large as that of oil and that the progress of the last fifty years in steamers has resulted in the creation of suitable coaling stations properly distributed throughout the world. The change over from coal to oil as fuel can, therefore, only be a gradual one, and possibly in the immediate future, Diesel engines will only be fitted to vessels which operate on routes where oil is found and produced in sufficient quantities to be available at reasonable costs. For other routes, development may tend towards the use of oil fuel with water-tube or cylindrical boilers in conjunction with a geared-turbine engine, so that a change-over from oil to coal, or *vice versâ*, can be made at short notice, so as to take advantage of the fluctuations of market price and thus improve the economic flexibility of the vessel.

Certain particulars contained in the 1921–22 edition of Lloyd's Register indicate the great development in the use of liquid fuel for steamship propulsion. Its use has increased from 3·1 per cent. in 1914 to 22·6 per cent. in 1921, and that of coal has decreased from 88·9 to 72·3 per cent. in the same period.

From another point of view, it may be recorded that whereas 290 vessels making 234,000 gross tons were fitted with internal-combustion engines in 1914, the corresponding figures in 1921 are 1447 vessels, aggregating 1,263,000 tons.

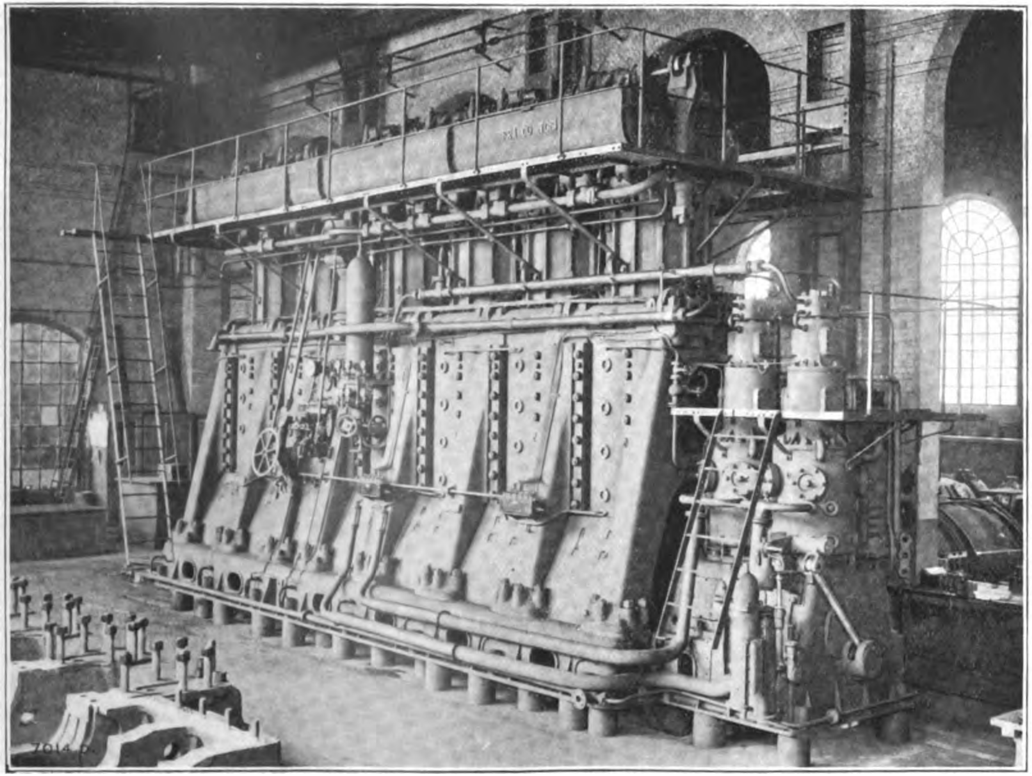
The figures bearing upon the use of oil fuel are also interesting. They show that whereas 364 steamers with a total tonnage of 1,310,000 were thus fitted in 1914, at the middle of the present year these numbers had increased nearly nine times, viz. to 2,536 vessels and 12,797,000 tons.

Collaterally with this growth, the oil companies have made enormous strides in the provision of tonnage for the distribution and transportation of oil throughout the world, and large storage centres have been developed at most of the principal ports. Compared with 1914, the vessels suitable for the carriage of petroleum in bulk have been increased by about 200 per cent., the respective figures being approximately 1½ million gross tons in 1914 and nearly 4½ million tons in 1921.

If from these latter figures vessels of under 2,000 tons be omitted as being useful for local distribution only, there would still be left some 730 vessels of an average size of about 5,900 tons gross.

As with other classes of marine traffic, the present tendency in the economic transportation of oil is to increase the size of vessels, and steamers to carry 20,000 tons weight of oil, or even 25,000 tons, are either under construction or immediately contemplated.

WESTCOTT S. ABELL.



1250 B.H.P. BEARDMORE-TOSI MARINE OIL ENGINE.

## CHAPTER II.

### PROPELLING MACHINERY IN THE MERCANTILE MARINE.

DURING the period under review, 1920–1921, the extremely difficult and greatly fluctuating conditions the world over and in all industries have naturally had a severe effect in checking shipping, shipbuilding, and marine engineering progress. High costs of labour and materials have made imperative the closest scrutiny into the operating costs of vessels, although this position has its compensating advantage in stimulating the concentration of technical effort towards the desired end of minimum overall cost of operation per ton mile.

Never before has it been so generally recognised that the cost per ton mile in conjunction with a suitable speed for the trade in which the vessel is engaged, are the dominant factors, and it is pleasant to express the firm belief that this realisation is brought about, at least, quite as much by the gradual gaining of mechanical knowledge and engineering experience by the shipowner as by the somewhat dire necessities of the present crisis in this industry. Coupled with this statement, it is interesting to record that at no previous stage in the history of mechanical marine propulsion, have there been such a number of varied types of machinery issuing a challenge of maximum overall efficiency. The scope of all of these alternatives is not the same, some being very limited as regards powers for which they are suitable. There is, nevertheless, considerable overlapping, and time alone will serve accurately to define the field of application, to eliminate the unsuitable, and to adjudge the results. This great variety of types emerges, in measure, from the intense effort made during the war in naval engineering and in the mercantile marines of all countries to replace the losses due to unrestricted submarine warfare. Machinery that would not have been considered suitable for marine work under normal conditions was pressed into service to help to fill the widening gaps in available tonnage to transport the necessities of the belligerents. Most of these types have survived. The various systems which will be discussed are the reciprocating steam engine, turbines without and with gearing—mechanical, electric, or hydraulic —and the Diesel oil engine driving the propeller directly or with the interposition of the same speed-reducing media as are applied in the case of the steam turbine.

### THE TRIPLE-EXPANSION STEAM ENGINE.

For the great class of medium-powered cargo carriers and tramps, the triple-expansion steam engine still holds the field, although it is now being seriously challenged. Comparison with other types of

plants, in general, only serves to emphasise its great suitability for driving a propeller in the freight-carrying marine. It is sometimes insufficiently emphasised that the prime mover adopted for any power scheme must be related to the mechanism which its function is to drive, and with an average vessel, making long voyages in all conditions of draught, sometimes laden down to the marks, other times light, observing that the propeller torque is far from regular, the steam reciprocator, with its steam cushion on both sides of each piston, makes an arrangement difficult to surpass for mechanical soundness. Further reference to this particular aspect of the subject will be made when dealing with mechanical reduction gearing.

The principal improvement with this standard type of marine equipment has been the extensive fitting of smoke-tube superheaters to cylindrical boilers to give in service varying degrees of superheat up to 200° F., to increase the range of temperature between which the prime mover works, and so to improve the economy. Earlier superheating difficulties experienced with the high pressure piston rings, packing, and lubrication, have been overcome, and the extra economy much more than balances the inaccessibility of the boiler tubes due to the fitting of superheater elements. The resulting fuel saving may be said to be 8 per cent. for every 100° F. of superheat. Sometimes figures of economy are stated as a percentage of steam saved, but this is misleading, since superheated steam takes more fuel for its generation and superheating than is required to produce an equal quantity of steam in a saturated condition. The savings in fuel in practice, however, as stated, are substantial. As a corollary to the installation of superheaters, improved means have been developed, and are increasing in favour in order to prevent the efficiency of the superheater from being reduced due to a high percentage of water being carried over with the steam, and to minimise the clogging and attendant burning of the superheater elements due to the presence of impurities. To maintain the smoke tubes, partially filled with the superheater elements, free from soot, steam blowers are always fitted. The auxiliary equipment will be separately dealt with later.

Excepting where fuel, especially in the case of coal, is so cheap that the question of first cost is one of very great importance, the steam reciprocator will require to give way to its more economical rivals. With all other types of marine machinery the influence of war-time developments is strongly felt, and in this connection unquestionably as time advances, it is proved that success under stress of war conditions, when expediency was the primary consideration, does not necessarily imply complete suitability for normal times when pounds, shillings, and pence, both in first and operating costs, are the principal arguments.

## Steam Turbines.

Steam turbines, generally of the Parsons and Brown-Curtis types, have found an ever-increasing field of application, as direct-driven or with single or double reduction gears, for the largest type of

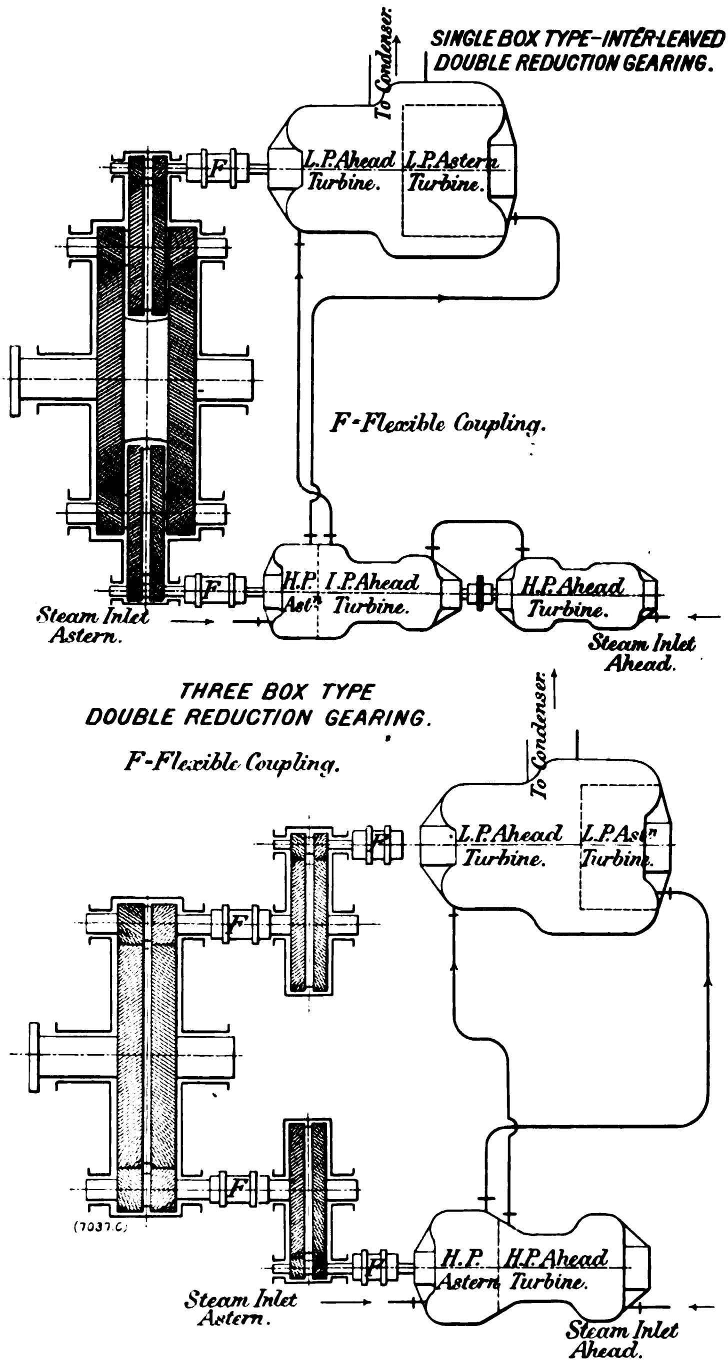
craft afloat, and with double reduction for medium and low powered vessels. Without the introduction of gearing to reconcile the conditions for maximum efficiency of the turbine and of the propeller, the number of vessels, for the propulsion of which the steam turbine could now be advocated in the light of extended experience, is limited to those of relatively high power and speed. With vessels below fifteen knots average sea speed, the double reduction gearing is called upon to give such overall economy as will compare with the quadruple-expansion superheated steam engine with improved modern condensing plant.

There have been no radical changes in turbine design. The method of fixing blading has been gradually improved, until, at the present time, the chances of a turbine shedding its blades or "stripping" are extremely remote. Superheated steam is universally adopted up to 200° F. of superheat, *i.e.* the same maximum temperature as with reciprocating steam machinery, and there would seem to have been dispelled the "bogey" of the dangers of the sudden admission of high-temperature steam to the element for astern running, raised principally by the advocates of electrical transmission—where no astern turbine is required. To cope with high-temperature steam, blading material of phosphor bronze has proved successful. The saving consequent upon the adoption of superheated steam with turbines is not so great as is the case with reciprocating engines; probably 5 per cent. instead of 8 per cent. per 100° F. is an appropriate figure for the fuel saved. This lesser amount is due to indirect gains such as reduced condensation being of smaller moment with the turbine. The overall length of reaction turbines has been reduced by the introduction of impulse stages to absorb a greater proportion of the energy of the steam, and whipping is now rarely encountered.

In the largest twin-screw ships, three turbines per side, geared to the propeller shaft, have been commonly fitted. In these turbines the steam is successively expanded as in the H.P., I.P., and L.P. cylinders of a triple-expansion steam engine. Astern turbines are generally incorporated with both the I.P. and L.P. ahead units, so to balance the effort when running astern. Excepting for high-power installations or where the highest degree of economy is essential, two turbines per shaft, an H.P. and an L.P., are sometimes preferred as giving a more simple arrangement, and similarly for single screw ships, except that both the H.P. and L.P. in this case must incorporate astern elements to ensure safety.

## Mechanical Gearing.

The re-acceptance of mechanical gearing, which, since the Parsons single-reduction geared ship the s.s. Vespasian in 1909, up to date has been fitted, or is under construction, for well over 10,000,000 H.P. of marine machinery, is one of the most remarkable milestones in the progress of mechanical propulsion at sea. Great impulse to this movement was given by the uniform success of the millions of horse-power of single-reduction gearing (the few cases where a




TYPE OF DOUBLE-REDUCTION GEARED TURBINES.

cruising turbine was additionally geared to the H.P. turbine spindle can hardly be called double-reduction gearing) fitted to naval vessels during the war, which performed admirably under full stress of war conditions.

With double-reduction gearing, as applied to merchantmen, the results to date have not been so definite nor so uniformly successful. The arrangement most favoured is to include all the gear wheels and pinions in one box, interleaving the first reduction wheel into the second reduction wheel, and so economising in space and weight. The alternative arrangement next in favour is to have three separate gear boxes; one for the high-pressure turbine and one for the low-pressure, each serving for the first reduction, and the wheel spindle of each driving one of the two pinions engaging the wheel on the main shafting in a separate box, forming the second reduction. This arrangement may have some advantages by way of allowing greater freedom to the second-reduction pinions, especially where truly flexible couplings are provided between the first-reduction wheel spindle and the second-reduction pinions; but it certainly is almost as clumsy as to be a considerable disadvantage where higher than very moderate powers have to be dealt with.

## Difficulties with Gearing.

The difficulties experienced, chiefly confined to the second reduction gear, are wearing of the teeth with the accompaniment of undue noise and excessive pitting. With single-reduction gears, pitting is not unknown, but is of a type that practically ceases after the first few runs, and seems to be merely an initial process in the bedding together of the teeth of the pinions and the wheels.

With double, as distinct from single reduction gearing, the forces tending to cause difficulty to the various teeth in their automatic endeavour to find a true bearing, with the double-helical arrangement of teeth, are certainly complicated by the oil clearance that has to be given to the bearings to ensure correct lubrication. Experiments with Michell main bearings in the gear case are in progress, and the results will be watched with interest. With the well-known Michell principle as applied to journal bearings, the oil clearance can be reduced to a fraction of that required in the usual design.

Apart from this question, there can be no doubt that accuracy of machining work and fitting in the actual cutting of the teeth, governing the dimensions of the pitch and the helical angle, and in the machining and fitting controlling the alignment of the shafts of the gearing, are matters of an importance so great that it cannot be exaggerated. It has been stated that the teeth should be accurate as regards thickness and pitch to within 0·005 in., and it is certain that this can be achieved, although a number of gears are at sea where the inaccuracy is very much greater.

In respect of alignment, no standards have yet been formulated, and the question is undoubtedly complicated by the influence of the strength and rigidity of the seating in the ship for the gear box, as well as by the rigidity of this element itself. Further light still

requires to be thrown on these questions, and will in time be supplied from the experience of the large number of such installations afloat and building, and soon to be in service. The actual process of forming the teeth is being subjected to close study, and there are a number of methods of cutting—hobbing with and without the "creep" table, planing, and so forth, all claiming to give equally satisfactory results. In the past sufficient attention has not been given to the actual teeth-cutting machine, the rigidity and alignment of which should be superior in degree of accuracy to that desired with the product.

A further point of considerable importance, and definitely responsible for certain cases of unsatisfactory working, is the hammering action between the teeth which, in certain cases, has been occurring, and is caused by the natural periodicity of torsional vibration of the shafting coinciding with the variations in turning moment of the propeller, due to its action in the ship's wake. Again when pitching occurs, especially with the ship light, there are present conditions making for the unequal engagement of the teeth and causing fluctuations of pressure. With a short length of shafting between the gear wheel and the propeller, these forces are intensified. Taking these two points, alignment and accuracy, and the hammering action, it will be conceded that the gearing question is by no means simply one of designed pressure between the teeth of so many pounds per lineal inch. Whatever the designed figure, it may only be a small fraction of the actual load should alignment be faulty or should hammering take place.

## Methods of Reducing Difficulties.

In America, the Melville-McAlpine floating pinions are often fitted. The chief claim made for this gear is the possibility thereby of achieving better accommodation of the teeth to any inexactness in the helical angles to permit of higher loads being safely carried. It is not accepted here that this accommodation is required, or that this device definitely succeeds in counteracting the effects of such errors as may occur. To mount both the first and second reduction pinions in floating frames is certainly a complication undesirable for mercantile work, if it can be avoided.

The mere fact of hammering suggests arrangements towards a degree of flexibility in the mechanism between the propeller and the turbine so that inequalities of torque at the propeller end shall be absorbed and shall not be transmitted to the teeth. The teeth of the pinion connected to the turbine are continuously held up to their work by the large flywheel effect of the fast-running turbine rotor. Various means to the end of giving flexibility have been tried out. The turbines are, of course, always coupled to the pinions which they directly drive with a flexible coupling, allowing some freedom of end movement, and recently, in certain cases, by a coupling allowing also independent freedom of axial and angular movement from the pinion. This coupling is introduced to prevent restraint of the pinions due to temperature end expansion of the turbine and to allow for any slight lack of alignment of the pinion. To ensure that the flywheel effect

of the rotating turbine rotors shall not constrain the gearing to run with a degree of regularity of angular velocity out of keeping with the propeller the quill drive has been used, principally in the United States of America. This drive consists of coupling the turbine to the pinion by a spindle of minimum diameter, giving torsional flexibility, running through the centre of the hollow pinion and coupled to this pinion at the end remote from the turbine.

A further development on these lines is the "Nodal" drive developed by Messrs. Workman, Clark, of Belfast, incorporating quill drives for the pinions, in which the dimensions of the quills are definitely calculated to give the desired degree of flexibility so that torsional vibration, if present, will take place forward and aft of the gearing. The node of no vibration will thus occur within the gearing itself, and the contact between the meshing teeth will be continuous and even. This interesting scheme has been incorporated in the gearing of the s.s. Melmore Head with results which, it is understood, are in direct and satisfactory contrast to the noisy running and very excessive wear previously experienced in this ship with two earlier sets of gears, both of which had worn out. This device loses the elemental advantage of maximum simplicity of the normal double reduction drive, and therefore must justify the slight complication incurred by proving that the application is necessary. It is nevertheless very probable that a greater degree of flexibility will require to be arranged for, with double-reduction gearing, between the turbine and the propeller, at least in certain cases where the conditions do not favour even pressure of contact and continuance of perfect alignment.

In the early days of the introduction of double reduction gearing a relatively large number of important sets of gearing in construction were altered very substantially to reduce the loading on the teeth. Whilst, in the state of knowledge of conditions and machine shop practice then pertaining, this was no doubt a correct decision, yet it is in no way proved that the loading of the teeth of the second reduction need be reduced to such low figures as 500 to 600 lbs. per inch run of tooth or that 1000 lbs. per inch run or even higher loads, and therefore pressures, cannot be successfully sustained with comparatively large pinions, provided that the workmanship and rigidity are of the requisite high order.

## Materials for Gearing and Lubrication.

One field that has still to be fully explored with marine gears is the question of the material of which the various pinions and wheels should be made. Nickel steel for the pinion and carbon steel for the wheels are generally favoured. In some cases the pinions have been made of nickel-chrome steel, but the opinion is generally held amongst marine engineers that this latter material is not yet available in such sizes and in sufficiently reliable supplies, to warrant its use for such an important part of the installation, and experience to date has tended to confirm this view. Hardening of the teeth and grinding of their profiles, is impossible with helical teeth, although

it is not uncommon practice with spur wheels, and a gear with spur teeth and hardened pinion teeth will shortly be tried out at sea. In operation, spur gears must be harsh compared with the gradual and sliding engagement of the double helical arrangement. It still remains to be proved that a greater difference in the qualities of the materials of which the pinion and wheel teeth are made would not have beneficial results in causing the rubbing action to be more gentle. When a certain amount of inaccuracy in cutting must be worn down, abrasion towards a perfect bearing might then take the place of the somewhat violent pitting sometimes evidenced in such cases with the present materials.

An ample supply of lubricant must be delivered to the gearing to lubricate the rubbing surfaces, and to remove the heat. Failure of the supply has caused severe wear. Advocates of various qualities of lubricating oil, with and without graphite in suspension, press the claims of their lubricants. It has been suggested that the quality of the lubricant can cause a reduction in the amount of wear, but it is not proved that more than an ample supply of good mineral oil is called for. It seems that regularity of supply is the one essential in this respect. Since the sliding or rolling motion between each pair of meshing teeth has a varying velocity ranging from a maximum to zero and then reversing, it is probable that the oil film may be momentarily destroyed at the instant of no relative sliding or rolling.

## Results and Prospects.

The subject of double-reduction gearing has been somewhat fully dealt with because of its undoubted importance. No innovation, especially in the marine world, can expect to command instant success, although naturally from the successful results at sea of the single gear, such a hope was justifiably entertained by all concerned, when double-reduction gearing was strongly advocated and generally pressed into service. Whether or not double-reduction gearing represents the final solution to the equation of the turbine to the propeller, there is no reason whatever to suppose that the difficulties now being encountered will not be overcome, so that the double-reduction system may achieve substantially the same degree of reliability in a wide field of performance as the single reduction can rightly claim to have shown with the much fewer types of vessels to which it has been applied.

The full benefits of turbines and double-reduction gearing are certainly worth striving to attain. A number of ships are now operating satisfactorily on this system, although it is too early yet to make an absolutely positive statement either in regard to reliability under all conditions at sea, economy of operation, or durability. Wisely, it is recognised that the best success may be jeopardised by running for long periods at full power before the teeth have been carefully run into a good bearing, and most of the vessels so fitted have definitely been run, so far, at less than their full power and speed, which is inimicable to the obtaining of the highest economy. In considering the somewhat disappointing results of fuel consumption, so far

obtained in service, attributable partially also to the auxiliary machinery, the foregoing facts must be borne in mind and increased experience will no doubt tend to improve on present results. It is not substantiated yet what are the exact losses by way of friction, windage, etc., incurred with well-cut double-reduction gearing, yet it is certain that they have been considerable and greater than 2 or 3 per cent. in the majority of cases, although 2 or 3 per cent. may represent the total gearing loss with accurately machined and aligned gears.

### Steam-Electric System.

The other system in vogue which has for its object the attainment of conditions conducive to maximum efficiency of the turbine and of the propeller, is the steam-electric plant. The steam turbines drive alternators delivering alternating current to motors directly on, or geared to, the propeller shaft. Improvements in electric alternating current motors have now made possible the elimination of all gearing, so that the motors may be mounted direct on the shafting. Reversing is carried out by controlling the current to the electric motors, so that no astern turbines are required, and a higher degree of superheat, if desired, might on this account be carried. Under conditions of running at fractional powers, where more than one alternator are installed, certain economies are effected. For the average cargo-carrier, unless mechanical gearing is inadmissible, it is difficult to see wherein lie the advantages of the steam-electric system of propulsion. The economy at full power will not be improved, since 200° F. of superheat can be quite safely carried with geared sets and astern turbines incorporated with the low-pressure engine. The electric system is furthermore decidedly more costly in initial expenditure, and the combined steam and electric gear calls for a wider scope of skill and knowledge on the part of the engine-room personnel. The keenest advocates of this system are the engineers of the United States of America, where it has been energetically taken up for the Navy and has found considerable acceptance also in their mercantile marine. Little has been done here, although the s.s. Wulsty Castle,* equipped with two Ljungstrom turbo alternators built by the Brush Company of Loughborough, each of 625 K.W. capacity, when running at 3600 r.p.m. delivering alternating current at 650 volts and 60 cycles to two Brush Company's electric motors driving the single screw at 70 r.p.m. through single-reduction gearing, has been in operation for three years with, latterly, quite successful results. This fact shows that the system is in no way insuperably unsuited to the requirements of the mercantile marine, although, in this country, the conditions have not been such as to compel attention to its advantages—of capacity to carry the highest degree of superheat with safety, increased flexibility and ease of control, immunity from gearing troubles, economy at low powers, etc., as against the more simple and less costly direct-geared turbine.†

* See *Engineering*, May 3, 1918, p. 492.

† See "Electric Ship Propulsion," by R. J. Butler, M.I.N.A., the *Electrician*, July 29, 1921.

### Föttinger Transformer.

The only other method of coupling the turbines to the propeller with reduction in revolutions is by means of an hydraulic transformer such as the "Föttinger."* The war and mechanical gearing developments have been responsible for a complete suspension of interest in this device. The twin-screw liner Königin Louise, with turbine drive of a total S.H.P. of 4500, which ran successful trials on October 17, 1913, was lost at an early date, before data in actual service were available, and the performance of the Föttinger transformer in the German naval vessels in which it was installed has not been published. If it could be substantiated that this apparatus has a high degree of reliability and low cost of upkeep, then its claims to reconsideration † would merit further and full attention, especially when and if there be particularly strong objections to double-reduction gearing.

### Boilers and Auxiliaries.

During all these changes in the main propelling engines, the boilers and auxiliary machinery have, perhaps, been somewhat neglected. The cylindrical return-tube boiler remains the standard, and the only changes evident are concerned with details of construction, intended to replace hand labour by utilising mechanical means to the utmost extent.

The water-tube boiler, so necessary for naval work, finds no readier acceptance for the average merchantman. Recent innovations in boiler-feeding auxiliaries and fittings, such as the Weir's closed-feed system giving de-aërated feed, and the degree of reliability now reached by automatic boiler feed regulating devices, should make more favourable the claims of the water-tube boiler for general marine work. The risk of excessive pitting of water-tube boilers when fed with ordinary feed in the usual way, has hitherto been one of the drawbacks to their adoption, but with the closed feed system this risk should be reduced. The air is drawn from the condenser by a steam jet, separately condensed, and a turbo extraction pump deals with the condensate and delivers it to the feed pumps, which are also of the turbo type. With this system, very high vacua are obtained and on a recent round trip the average recorded was the remarkably high figure of 29·3 inches; moreover, there is little chance of the feed water becoming aërated.

The question of the relative consumption of steam, and so of fuel, of the auxiliaries to the main engine, naturally arises when efforts are made to gain a few per cent. increased economy, and it is probable that quite often the extravagance of these steam consumers, if fully realised, would lead to improved practice and a gain in over-all economy. The importance of this subject will be realised when it is stated that, in certain cases, the engine-room auxiliaries are re-

* See *Engineering*, August 15, 1913.

† See "Speed Reduction Gearing for Ship Propulsion," by Robert Love, read before the Institution of Engineers and Shipbuilders in Scotland, February 26, 1921.

sponsible for over 20 per cent. of the total fuel bill, considering work in port as well as time at sea.

The driving of auxiliaries such as electric generators, circulating pumps, fans, etc., by turbines, is gaining ground because of the great reliability of the prime mover having only rotary motion, the small space occupied, and the small repairs; but these gains must be balanced against the extra steam consumption of these small turbines. In computing such consumptions all allowances must be made for the return of the latent heat in the auxiliary exhausts through the contact heater, or, by the closed exhaust, to the L.P. turbine—where that portion of the auxiliary exhaust which is not required to heat the feed water to the economical temperature, is utilised, by being led to the appropriate stage of the low-pressure turbine, there to do work. One of the principal savings with the turbo electric system of transmission of propelling power arises from the economical electric driving of the auxiliaries, deriving current from an electrical generator of considerable size and so of relatively high economy. The electric motor is being gradually adopted in the machinery of large turbine ships, for the driving of fans for the boiler air supply, stand-by pumps, engine turning gear, and so forth, so that an extension of this practice making for overall economy can confidently be looked for in the near future.

## Oil Fuel.

The greatest change in the trend of affairs concerning marine machinery that has taken place since the earliest days is the all-conquering march of oil fuel. The number of ships converted, as well as those built, to burn oil under boilers, is remarkable. In 1914, 2·62 per cent. of the world's tonnage was so equipped, whereas at the present time this percentage has increased to 20·65. The advantages of oil-fuel burning are so substantial as to overbalance even a very considerable extra price per ton of liquid fuel. The change alone in boiler-room conditions is revolutionary. The reduction of personnel, the ability to maintain a full head of steam irrespective of expenditure of human energy, the elimination of fire and boiler-tube cleaning routine, the cleanliness, the relative smokelessness of combustion, the rapidity with which the ship can be bunkered, the increased radius of action for a given weight of fuel, facilitating a rapid turn round at the end of a trip, thus making for increased earnings—all these advantages serve clearly to explain the wide adoption of liquid-fuel burning.

There is, furthermore, always present the possibility, in the majority of cases, of reverting readily to coal, should the relative prices of oil and coal in the future reverse the present advantageous position of petroleum. The type of apparatus for burning liquid fuel under marine boilers by injecting the oil into the boiler furnaces by pressure alone, without the aid of a steam or compressed air jet, has arrived at a state of development of very high efficiency. Little trouble is experienced and there are a large number of alternative designs of systems of pumps, heaters, filters and burners which

give equally satisfactory results in practice with all qualities of bunker oil.

Any immediate doubts as to the continuance of the supply of petroleum should be dispelled by Sir Frederick W. Black's article on this subject on page 285. There is little reason to doubt that the steady, though naturally diminishing, increase in production in petroleum, which in 1920 was over 100 times that of 60 years ago, 10 times that of 50 years ago, and 117 per cent. greater than in 1910, will be maintained. The remarkable increase from the Mexican fields, where the 1921 estimate based on three months' working gives eight times the quantity produced in 1916, may be cited.

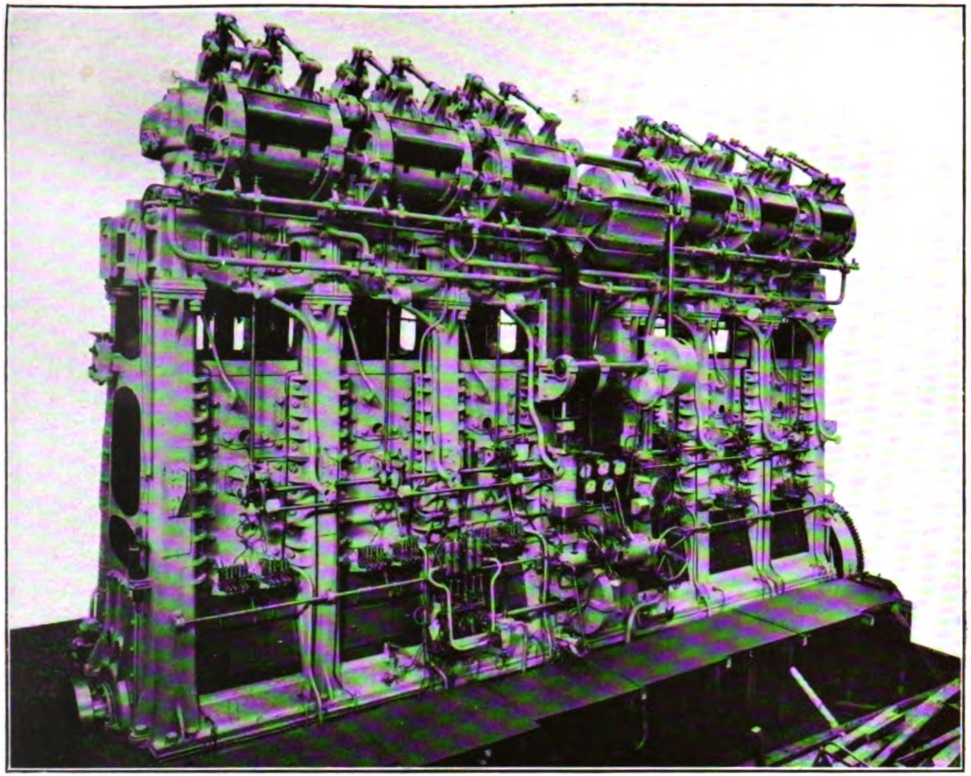
Whereas petroleum only represents in weight some 7·3 per cent. of the world's total fuel production, including coal and oil, yet in calorific value and in power-producing capacity this 7·3 per cent. is increased to 12 per cent. with steam plants, and to much more than 12 per cent. if used in internal combustion engines. However, the major portion of the world's coal serves for process work in the steel, metal and chemical industries, so that the relative position of oil to coal where power production proper is concerned, is much more important than the bald 7·3 per cent. figure would suggest. Furthermore, wherever a plant has to develop power to propel freight as well as its own weight and bulk as in traction and marine work, the claims of liquid as against solid fuel will be intensely strong. Ashore, where weight and space do not prevent complete coal handling and firing plant being installed, the position is different.

There is present, however, the danger that the demand for liquid fuel may exceed the available supply to a sufficient extent to upset the favourable oil prices now ruling. Increased oil-tanker service, which important class of vessel has increased from 3½ per cent. of the world's shipping in 1914 to 7 per cent. at the present time, with a large number still under construction, has assisted in reducing oil prices. Since 1919, bunker oil has fallen some 50 to 60 per cent. in price, *i.e.* from £10 to less than £5 per ton. The only method of mitigating a shortage is by the most efficient utilisation of the various classes of oil on the market. The better grades should not be burnt under boilers when the Diesel oil engine, in marine practice, can give per ton of fuel approximately three times the effective power output of the best steam plant of equal power.

## The Diesel Oil Engine.*

Steady progress has been made in applying the Diesel engine to marine work. Naturally, the change from steam to this type of prime mover is a very revolutionary one, and could not be expected to take place suddenly, especially with oil prices only strongly favouring its adoption within the last few years, and in view of the fact that in installing oil engines, there is no possibility of reverting to coal, and

* In the Merchant Shipping Appendix there will be found various tables regarding oil engines, supplementary to the particulars given in this chapter, namely, tables of Oil Fuel Ports, with a map showing the location of these; a table of Comparative Costs of Steam and Oil Engined Vessels; table showing the Development of Oil Engines; diagrams showing the Operation of 4-Cycle Diesel Engines; and a table showing the Development of Oil Engines in Merchant Ships.



1250 B.H.P. MARINE OIL ENGINE, VICKERS' SOLID-INJECTION TYPE,
FOR M.S. SEMINOLE

the shipowner is practically pledged to the liquid fuel for the life of the ship. Moreover, had the adoption been more rapid than actually has been the case, engineers with the necessary experience and knowledge would have been lacking. At the present time there is not an excess, although the number with a knowledge of the simple forms of internal combustion engines is sufficient to dispel any fears on this score, provided the Board of Trade's Regulations, shortly due to become operative, are suitably amended to allow for the inevitable transition.

Oil-engined vessels have increased since 1914 from 0·47 per cent. of the world's tonnage to 2 per cent., and whereas in 1913, 60,000 tons of shipping to be equipped with Diesel machinery were launched, there was building last year 454,502 tons, or 7 per cent. of the world's total. This last figure is sufficient evidence of this growing movement, when taken in conjunction with the great number of types of oil engines shortly to be tried out. The success of a proportion of these types will certainly be achieved and will finally and definitely convert to this system of propulsion a large number of shipowners only awaiting demonstration. It will, therefore, clearly be seen that we are now on the eve of a great development in the application of the Diesel oil engine to the mercantile marine. The savings effected by the Diesel system have been fully dealt with (see last year's "Annual," page 183), and it only requires to be emphasised herein that gradually increasing experience has shown the economy claims made to be fully borne out in practice and the fuel savings to be steadily maintained.

As developed to date, the Diesel engine is only suitable for small and medium-powered vessels. From 1912 to the present time, the horse-power per cylinder has risen by small steps from little more than 100 to slightly over 300 B.H.P., and, with multiplication of cylinders, a maximum power of approximately 4,800 B.H.P. (with 16 cylinders on twin screws), equivalent to 5,500 I.H.P. of steam plant, per ship, can be obtained with machinery of proved design for marine conditions. The maximum number of cylinders that can be applied to a medium-powered ship is limited by the fact that more than 2 propellers are undesirable, but there is no reason why more than 8 cylinders should not be fitted per shaft. With submarine engines direct-coupled to the main shafting, 10 and 12 cylinders, working on the four-cycle principle, gave admirable results without any disadvantage from the number of cylinders being evidenced. The marine engineer has a natural aversion to a multiplicity of cylinders, and fears for the durability of the crankshaft are entertained. With all reciprocating engines, crankshaft failure, although very exceptional, must be legislated for, and, where oil engines are concerned, the high pressures, uneven turning moment, and greater length, call for special consideration to be given to this question. There is no reason, however, if care is exercised in the design and construction of engine seating, bedplate structure, and crankshaft for strength and rigidity, observing that the bending moment consequent upon the combustion pressure stresses the shafting to a much greater extent than the twisting moment, why 12-cylinder engines working on the four-cycle

principle should not be adopted. For achieving high powers, multiplying the number of cylinders is a more sure path than increasing the diameter and power of the unit, and the complication ensuing from such multiplication is more apparent than real when it is borne in mind that all the units are identical and interchangeable. Later, in considering Diesel electric machinery, this question is further developed. This aspect of the subject is treated somewhat fully in order, as far as possible, to dispel the suspicion with which engines having more than 6 cylinders are sometimes viewed. Allowing, however, that 4,800 B.H.P. or 6,400 Diesel I.H.P., equivalent to slightly over 5,500 I.H.P. of steam machinery, is the maximum that can be put forward to-day by a proved type of oil engine, it can be stated that Diesel machinery is suitable to a very large proportion of the total sea-borne tonnage. In 1920, of 364 ships launched of more than 2,000 gross tons each, 350, or 96 per cent. of the total number, required less than 5,500 I.H.P. of machinery per ship. In numbers, 96 per cent., and in tonnage, 88 per cent., thus came within the scope of the oil engine, so far as total horse-power is concerned, although twin screws have still generally to be resorted to above some 2,400 S.H.P. With steam machinery, single screws would suffice for powers up to 5,500 I.H.P. These figures of percentages are, of course, slightly higher than the normal, because of the present high costs of construction having, in some measure, suspended construction on the largest type of craft for which the oil engine is not yet suited. They serve sufficiently well, however, to give in perspective the large field for which the oil engine is now applicable, so far as total horse-power is concerned.

## The Four-Stroke Cycle.

In all the applications of internal combustion engines, the simple four-stroke cycle principle, as fully explained in the last edition of the "Annual," still remains predominant. The figures for last year, the latest analysis available, showed that 80 per cent. of the marine Diesel horse-power then under construction was designed to operate upon this principle. At the present time, however, there will be a slight increase in the relative number of two-cycle engines being built. Those countries where the marine oil engine received its first impulse, due to prevailing conditions there regarding costs of coal and oil fuel, were neutral during the war, and, since 1912, a steady and consistent policy of development of the type they introduced has taken place. This type, the four-stroke cycle, single-acting, crosshead type of engine, with forced lubrication, has been subjected to that process of gradual evolution best calculated to achieve steady success and sure progress.

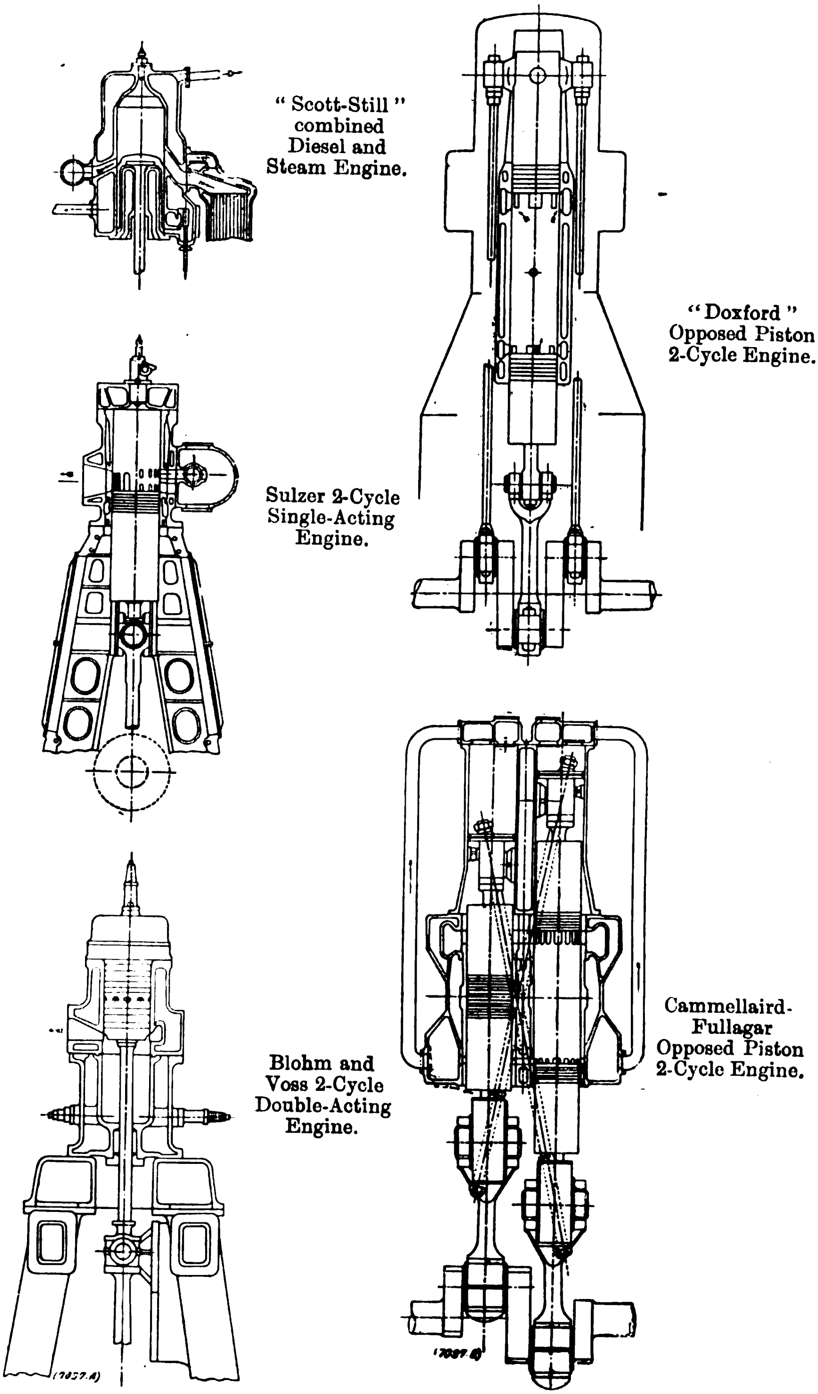
In these countries—Denmark, Sweden and Norway—statistics for June, 1921, show 47 motor ships of 146,761 tons under construction, to be engined almost exclusively with the four-cycle, single-acting type of engine. As evidence of the confidence of experience there established, it is to be remarked that half the tonnage under construction is engined with Diesel machinery. In Switzerland

LIST OF IMPORTANT DIESEL SHIPS IN SERVICE AND BUILDING, GIVING PARTICULARS OF THEIR MACHINERY.*

| Date. | Name of vessel. | Makers of machinery. | Type of engine. | Cycle. | I.H.P. of engine. | B.H.P. of engine. | No. of cyl. | B.H.P. per cyl. | Dia-meter or cyl. in in. | Stroke ins. | Ratio stroke to bore. | Revs. per min. | Piston speed. Ft. per min. | M.E.P. on B.H.P. basis. | M.I.P. on I.H.P. basis. | Consumption of fuel lbs. per sq. in. piston area per hour. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1912† | Juno | Werkspoor | Werkspoor | 4 single act, | 1 460 | 1,100 | 6 | 183 | $21\frac{1}{8}$ | $39\frac{3}{8}$ | 1·87 | 125 | 820 | 84·0 | 111·0 | 0·219 |
| 1919† | Glenapp | Harland & Wolff | Burmeister and Wain | 4 single act. | 3,200 | 2,625 | 8 | 328 | $29\frac{1}{2}$ | $43\frac{5}{16}$ | 1·46 | 115 | 830 | 76·0 | 93·0 | 0·202 |
| 1920† | Afrika | Burmeister & Wain | Burmeister and Wain | 4 single act. | 2,250 | 1,700 | 6 | 283 | $29\frac{1}{8}$ | $45\frac{1}{8}$ | 1·55 | 115 | 865 | 65·0 | 86·0 | 0·179 |
| 1920† | Glenogle | Harland & Wolff | Burmeister and Wain | 4 single act. | 3,200 | 2,625 | 8 | 328 | $29\frac{1}{8}$ | $45\frac{1}{8}$ | 1·55 | 115 | 865 | 75·0 | 91·5 | 0·206 |
| 1920† | Cubore | Bethlehem Steel Co. | Bethlehem | 2 single act. | 3,900 | 2,700 | 6 | 450 | $25\frac{1}{2}$ | 48 | 1·87 | 100 | 800 | 73·0 | 105·0 | 0·39 |
| 1920† | Ansaldo San Giorgio III | Ansaldo San Giorgio | Ansaldo | 2 single act. | 1,600 | 1,200 | 4 | 300 | $24\frac{13}{16}$ | $35\frac{7}{16}$ | 1·43 | 110 | 650 | 63·0 | 84·0 | 0·272 |
| 1920† | Fullagar | Cammell Laird | Fullagar | 2 opposed p. | 660 | 500 | 4 | 125 | 14 | 20 | 1·43 | 110 | 367 | 73·5 | 97·0 | 0·179 |
| 1920† | Fritz | Blohm & Voss | M.A.N. | 2 double act. | 1,250 | 850 | 3 | 283 | $18\frac{7}{8}$ | 28 | 1·48 | 110 | 515 | 65 0 | 93·5 | 0·223 |
| 1920 | — | Swan Hunter & Wigham Richardson | Polar | 2 single act. | 1,500 | 1,130 | 6 | 188 | 18 | 37 | 2·06 | 115 | 710 | 69·0 | 92·0 | 0·325 |
| 1921 | — | Gotaverken | Burmeister and Wain | 4 single act. | 1,600 | 1,200 | 6 | 200 | 25 | 51 | 2·04 | 95 | 865 | 67·0 | 89·5 | 0·171 |
| 1921 | Domala | N.B. Diesel Co. | N.B. Diesel | 4 single act. | 2,330 | 2,000 | 8 | 250 | $26\frac{1}{3}$ | 47 | 1·77 | 96 | 750 | 79·5‡ | 92·0 | 0·191 |
| 1921† | Sardinia | Werkspoor | Werkspoor | 4 single act. | 2,140 | 2,600 | 6 | 266 | $26\frac{3}{8}$ | $47\frac{1}{4}$ | 1·79 | 100 | 788 | 82·0 | 110·0 | 0·204 |
| 1921† | Seminole | Vickers, Ltd. | Vickers | 4 single act. | 1,620 | 1,250 | 6 | 208 | $24\frac{1}{2}$ | 39 | 1·59 | 118 | 767 | 76·0 | 99·0 | 0·185 |
| 1921 | Pinzon | Beardmore & Co. | Beardmore-Tosi | 4 single act. | 1,600 | 1,200 | 6 | 200 | $24\frac{3}{8}$ | $38\frac{3}{8}$ | 1·57 | 120 | 767 | 74·0 | 98·0 | 0·180 |
| 1921 | — | Stephen & Sons | Sulzer | 2 single act. | 2,200 | 1,650 | 4 | 412 | $26\frac{3}{4}$ | $43\frac{5}{16}$ | 1·62 | 85 | 610 | 78·0 | 108·0 | 0·321 |
| 1921† | "Conde de Churruca" | Messrs. Armstrong Whitworth & Co., Ltd. | Sulzer | 2 single act. | 1,700 | 1,250 | 4 | 312 | $23\frac{5}{8}$ | 37 | 1·56 | 100 | 615 | 76·0 | 103·0 | 0·314 |
| 1921† | — | Cammell Laird | Fullagar | 2 opposed p. | 1,580 | 1,200 | 4 | 300 | $18\frac{1}{2}$ | 25 | 1·35 | 115 | 480 | 77·0 | 101·0 | 0·248 |
| 1921† | Yngaren | Doxford | Doxford | 2 opposed p. | 3,000 | 2,700 | 4 | 675 | $22\frac{13}{16}$ | $45\frac{5}{8}$ | 2·0 | 77 | 585 | 93·0 | 103·0 | 0·362 |
| 1921 | Suphenco | James Craig Engine Works, U.S.A. | Craig | 4 single act. | 2,240 | 1,850 | 6 | 308 | 30 | 48 | 1·6 | 105 | 840 | 68·5 | 82·0 | 0·183 |

* Reproduced from a paper on "Recent Progress in Large Diesel Engines for the Mercantile Marine," read at the Engineering Conference of the Institution of Civil Engineers, July, 1921, by James Richardson, B.Sc., A.M. Inst. C.E.

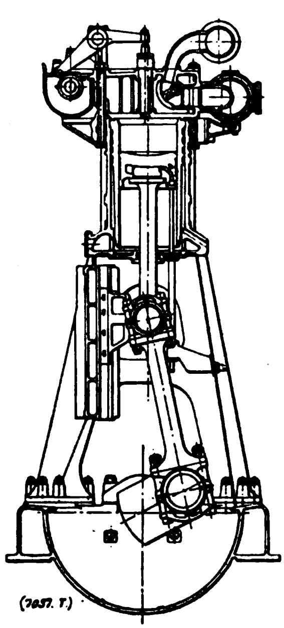
† In operation at sea. ‡ No compressors on main engine



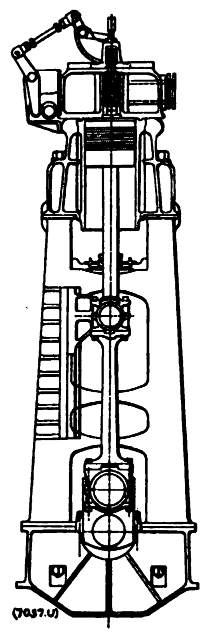

REPRESENTATIVE TYPES OF 2-CYCLE DIESEL ENGINES.

and Italy the two-cycle marine Diesel engine finds its strongest protagonists, whereas in the United Kingdom, where 57 motor ships of 241,003 tons were under construction in June, 1921, or almost as much Diesel tonnage as in the remainder of the world, both the two-cycle and four-cycle principles are being followed, with a preponderance of four-cycle engines.

The amount of Diesel tonnage building at home marks great progress, and when considered in conjunction with the large number of new types of engine now under construction and being tried out, indicates a progressive policy of determined trial, in contrast with the apathy with which British marine engineers were charged before the war.



Beardmore-Tosi 4-Stroke Engine.



Vickers 4-Stroke Solid Injection Type Engine.

Representative Types of 4-Cycle Diesel Engines.

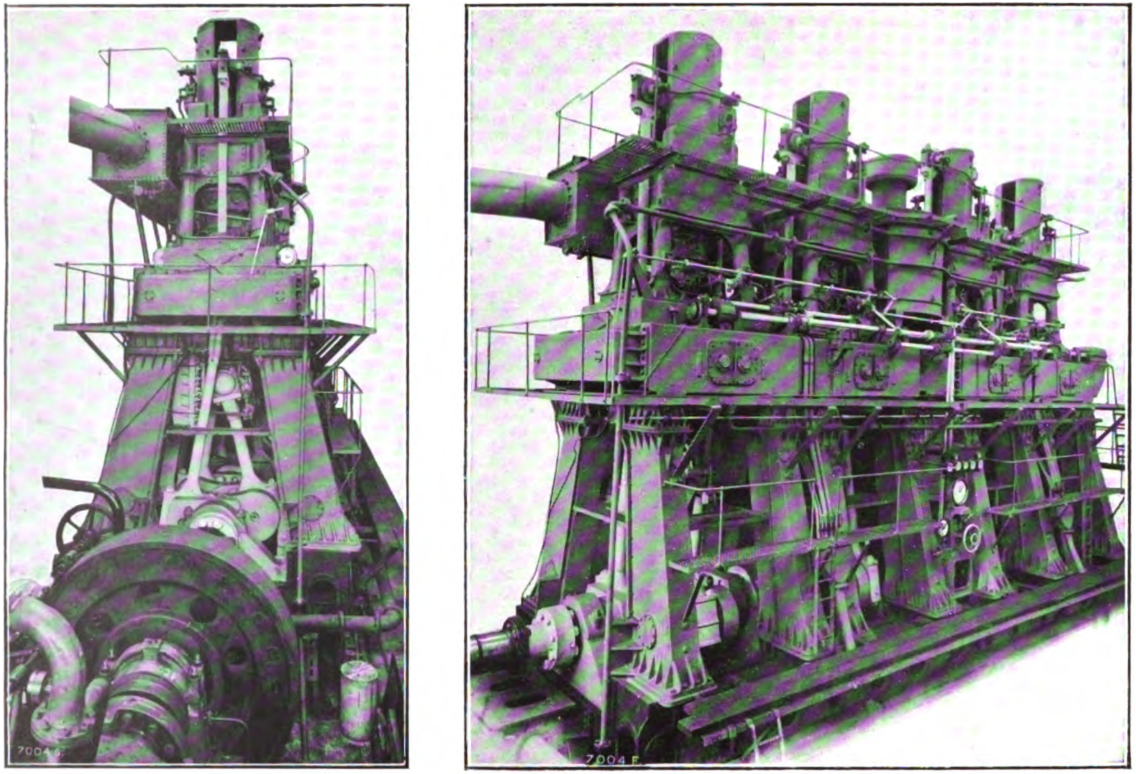
So many and varied are the types that it will be interesting to describe the leading features of the main examples of each. The table on page 227 gives the main dimensions of typical engines. The four-stroke, single-acting, air-injection type of engine is being manufactured by Messrs. Beardmores (Tosi), and Richardson Westgarth (Beardmore-Tosi), Harland and Wolff (Burmeister and Wain), the North-British Diesel Engine Company, the North-Eastern Marine Engineering Company (Werkspoor), whilst Messrs. Vickers, Ltd., of Barrow-in-Furness, are building their own type of solid-injection four-cycle, single-acting engine. These engines, all resulting from sea-going experience, in some cases extending over ten years, have in the main gradually merged towards a partially standardised type, not yet, however, so rigidly following

identical lines as the much more developed and standardised triple-expansion steam reciprocating engine. The leading features which have proved essential, forced lubrication with an enclosed engine, framing of rigid iron castings firmly bolted up fore and aft, well-supported crankshafts, cam-operated valves, with generally a three-stage compressor driven by an extension on the forward end of the main crankshaft, are features to be found in almost all of the foregoing examples. The average horse-power for which these engines are being built lies between 200 and 300 B.H.P. per cylinder, and they are to be fitted chiefly to twin-screw ships. The general appearance of these engines will be seen from the sections on page 229.

### The Two-Stroke Cycle.

In the two-cycle engine, the greatest variety of types is evidenced. The Polar type is developed by Messrs. Swan, Hunter & Wigham Richardson; the Sulzer type by Messrs. Armstrong Whitworth, Denny, and Stephens and the Wallsend Slipway Co.; Messrs. Cammell Laird, and other licensees construct the Fullagar engine, while Messrs. Doxford build their own opposed-piston engine based on the Junker system, and Messrs. Scotts' Shipbuilding & Engineering Company, of Greenock, are developing the Still engine, which is a combined oil and steam prime mover. (See diagrams on page 228.)

The two-cycle principle with its cylinder-liner ports controlling the inlet and exhaust phases of the cycle, instead of valves in the cylinder head, lends itself readily to the variety of arrangements evidenced in the lists given in the table on page 227. In order to eliminate two strokes from the four-stroke cycle, the sweeping out of the exhaust gases and the introduction into the working cylinder, of a fresh charge of air under a slight pressure from separate pumps instead of being controlled by the main piston and taking approximately 360° out of the 720° of revolutions required to complete the cycle, must, with the two-cycle principle, be accomplished in some 130° out of 360°. So long as the scavenging air was admitted through valves in the cylinder head, although this arrangement makes for a good scavenge of the cylinder from the head to the ports at the opposite end, the two-cycle principle did not make much headway, difficulties with cylinder heads of all types of construction being extreme. However, with the introduction of port scavenging in its simplest form, as in the Polar engine, or with the super-scavenging method as developed by Messrs. Sulzer, the cylinder head was simplified and competition with the four-cycle system became more feasible. The advantage of the Sulzer double-port system, where the upper of the two rows of scavenging ports in the cylinder liner are controlled by a positively operated rotary valve, is that after the exhaust ports have been covered by the piston on its up, or compression, stroke, extra scavenging air is admitted into the cylinder ensuring a more complete charge and effecting a considerable, and most desirable, cooling effect on the walls. Particulars of marine engines building in which this system is




2700 B.H.P. MARINE OIL ENGINE, DOXFORD OPPOSED-PISTON TYPE, FOR M.S. YNGAREN.

adopted are given in the table. With a number of these engines, scavenging air will be supplied by separate rotary blowers, which is an innovation, having the advantage of maintaining more constant the cylinder final compression pressure, which is dependent on the scavenging air pressure at which compression starts, irrespective of the revolutions of the main engine, and so facilitating slow running.

With the Diesel engine, the massive nature of the structure of the engine relative to the power output is a characteristic of the type of prime mover. The reason, of course, is the very high ratio of the maximum to the mean-effective pressure. The ratio is of the order of six or seven to one, so that, whereas the structure has to be designed to withstand, with a fair margin of safety, a maximum working pressure of over 500 lbs. per square inch, the mean-effective pressure on a B.H.P. basis is approximately 75 lbs. per sq. inch. Again the engine framing, necessarily designed for the maximum pressure, is only called upon to withstand this pressure, with a four-cycle single-acting engine, for one-eighth of the total running time. The maximum working cylinder load, for example, with a four-cycle cylinder of 200 B.H.P., is more than 100 tons, and furthermore, this load, because of its rate of application, cannot be considered as a dead load but rather as a live one.

## Opposed-Piston Engines.

These considerations led early investigators towards a solution where these intense forces of combustion could be confined within the running mechanism of the engine. The opposed-piston engine resulted. The combustion takes place between oppositely moving pistons, which are connected together by forged steel links of the engine mechanism. Obviously, with oppositely moving pistons within one liner there is no cylinder head, so that inlet and exhaust valves cannot be accommodated and the engine must work on the two-cycle principle, for which it is remarkably aptly suited. One piston is arranged to uncover scavenging air ports at one extreme end of the cylinder liner, and exhaust ports are similarly uncovered at the other end by the other piston, so giving a straight through scavenge of the exhaust gases, with a high volumetric efficiency. The difference between the Doxford and the Fullagar engines lies in the methods adopted to couple together the two pistons. With the Doxford engine, the top piston is attached to a crossbeam the ends of which are coupled by side and connecting rods to cranks on the crankshaft, one at each side of the main crank to which the lower piston is connected in the usual way by piston rod, crosshead, and connecting rod. The pistons are, therefore, connected together through the medium of the crankshaft, and all the piston loads are taken by the rods and shaft. One liner, two pistons, and three connecting rods, crossheads and cranks form one unit. The first vessel with this type of engine, the Yngaren, has completed very successful sea trials. This machinery has the distinction of being the largest single-screw installation afloat, 2,700 B.H.P., and the power per cylinder, 675 B.H.P., is the highest so far installed in a motor vessel.

With the "Fullagar" system, the chief difference is that each of the main pistons is connected to the opposite piston in the adjacent line; thus the top piston of one line is coupled by oblique rods to the bottom piston of the adjacent line. Each bottom piston is connected to its crank by the usual mechanism of piston rod, cross-head, and connecting rod. Two liners, four pistons, two connecting rods and cranks form one unit.

## THE SCOTT-STILL ENGINE.

The Scott-Still engine forms a most interesting development. Many attempts have been made in the past to harness, for useful work, some of the heat going to waste in the exhaust and cooling water of internal-combustion engines. With the Still system, long and patient research and experiment have resulted in developing an engine where the top side of the piston is operated on in the usual way by the combustion of oil and the bottom side by steam generated in the combustion-cylinder jacket, assisted by the exhaust gases. The reaction of the two cycles, oil and steam, the one upon the other, results in gains in thermal efficiency with both, and in a correspondingly low fuel consumption of 0·375 lb. per B.H.P.* being attained, which is the lowest figure on record, 0·4 lb. being obtained with the four-cycle engine.

The advantage of fuel economy is not the only one. The engine is started and manœuvred on steam, with increased flexibility as compared with the usual Diesel system, and being virtually double-acting, can be said to utilise the materials of construction to advantage.

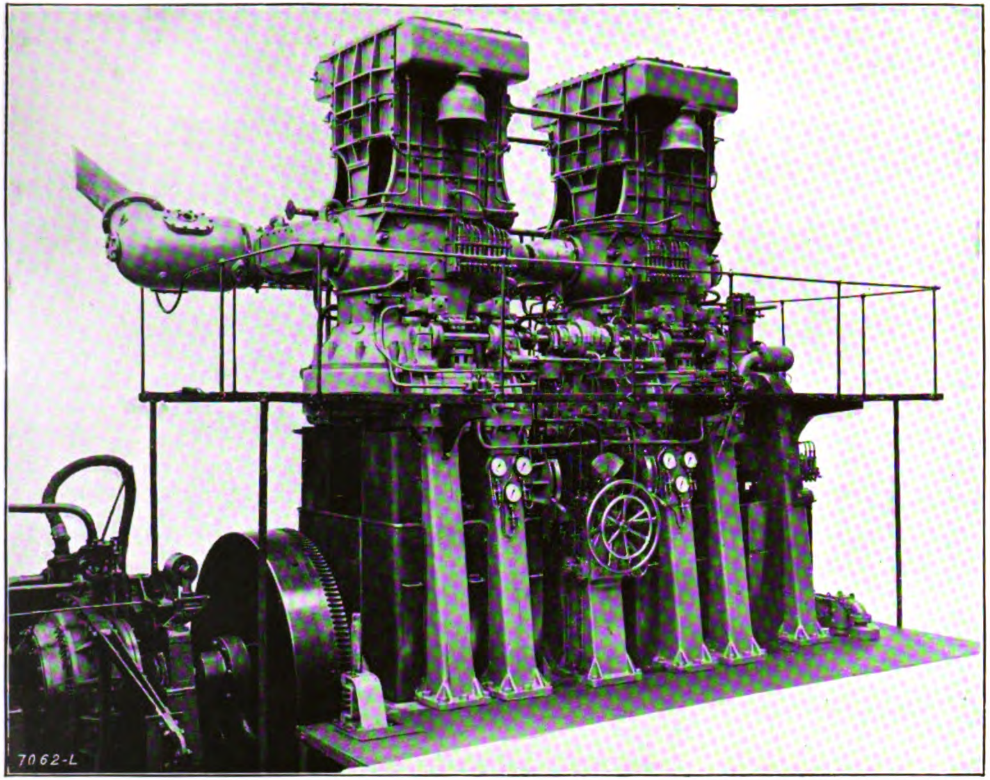
## PROGRESS AND PROSPECTS.

It falls to be recorded that progress has been made with the system of injection of the fuel without the aid of compressed air, *i.e.* the so-called system of "solid injection." The Vickers-engined oil tanker Narragansett has completed a year's successful service; the Doxford solid-injection engine for the m.s. Yngaren was subjected to a series of exhaustive trials on shore, using a wide range of qualities of fuel oil; and the Scott-Still engine runs on solid injection.

Increased confidence in oil engines finds expression in the increasing number of single-screw motor vessels being built, of which the Doxford and Beardmore ships building are interesting examples, although the great majority of motor vessels of comparatively large size at sea or building are twin-screw.

As utilising the material of the engine to better advantage, giving an even turning moment, and closely resembling the triple-expansion steam engine in general features, the two-stroke double-acting Diesel engine has often been referred to. In Germany before the war, this type of engine was being developed, and the Fritz was handed over to us on November 9, 1919, and subsequently renamed the

* See *En incering*, September 2, 1921, pp. 344-5.




500 H.P. CAMELLAIRD-FULLAGAR MARINE OIL ENGINE.

Assyrian. This ship has two engines each with three double-acting M.A.N. two-cycle Diesel cylinders, see the table, developing a total of 1,700 B.H.P. According to German publications, these engines performed admirably on trial on the test bed and at sea, but from an inspection of the cylinder design and scavenging arrangements, especially for the bottom half of the cylinder, and also from the full-power fuel consumption of 0·5 lb. per B.H.P. per hour, it is quite evident that this plant does not constitute an altogether satisfactory solution of the double-acting two-cycle engine. Messrs. Blohm and Voss are, however, still pursuing the line of development, although in the main the Germans, erstwhile strong advocates for marine work of the two-cycle engine, have reverted to the four-cycle type of engine, and the A.E.G. Company, new entrants there to the marine field, are pursuing an energetic policy of wide construction. The two-cycle double-acting engine is also being experimented upon at home.

### Mechanical and Electrical Gearing.

In America the Diesel engine geared to the propeller, mechanically and by means of electric dynamos and motors, is no novelty. Except in special cases, there seems to be little advantage in the mechanically geared Diesel engine, although in the only case where definite particulars have been given, the Libby Maine, * the single-reduction gears seem to have worked well. The Diesel-electric system, on the other hand, offers at present an attractive path to the attainment of the high powers with Diesel engines which the shipowner will demand and the engineer will be required to supply, as, for instance, for intermediate liners, etc. This system was first tried here on the m.s. Tynemount, † but was unsuccessful due primarily to the various units of the installation having an inappropriate power relation the one to the other. With such a system, the first cost cannot be low, and it will be difficult to keep the weights down, although these factors will not be a deterrent if by accommodating a larger number of cylinders and retaining the flexibility of electric machinery, higher powers can be more successfully sustained than with a necessarily fewer number of cylinders direct on the shaft. Developments in this system will probably take place at an early date.

### Fuel Oil for Diesel Engines.

There still remain many points to be cleared up in connection with the marine Diesel engine. All the fuel oil which comes on the market is not yet generally suitable for burning in this internal combustion engine, and the scope of application of the Diesel engine will undoubtedly be widened when it is proved that it can consume lower-grade oils economically in respect of the amount of attention to be given to the running parts. This problem is one of considerable and

* See *Engineering*, September 20, 1912, p. 387.
† See *Engineering*, April 8, 1921, p. 418.

immediate importance, since the types of fuel oils now coming on the market are showing a tendency to deteriorate in quality, to increase in viscosity, and to decrease in calorific value, so that the engine designer, constructor or operator must continue to study their efficient utilisation. A point of some importance here is that the Diesel electric system may quite possibly be able to utilise lower grades of fuels than are commercially advisable with the direct Diesel drive.

No attempt has been made to compare the various systems of Diesel engines. The bases of comparison must have regard to the qualities of fuel which they can consume on an equality of brake horse-power continuously sustained at sea, without running repairs and upkeep representing too great a proportion of the total operating costs of the ship. Whilst these factors are quite definitely known for the simple four-stroke cycle engine, time alone can decide the issue where the newer, ambitious and promising developments which have been more fully dealt with herein are concerned.

Definite information as to the power which various types of engines can consistently and continuously sustain at sea cannot readily be obtained. It is to be hoped that the results of sea-going experience will freely be disseminated and that the policy of secrecy, which is to be condemned and which in its initial stages particularly characterised this movement, will not be pursued.

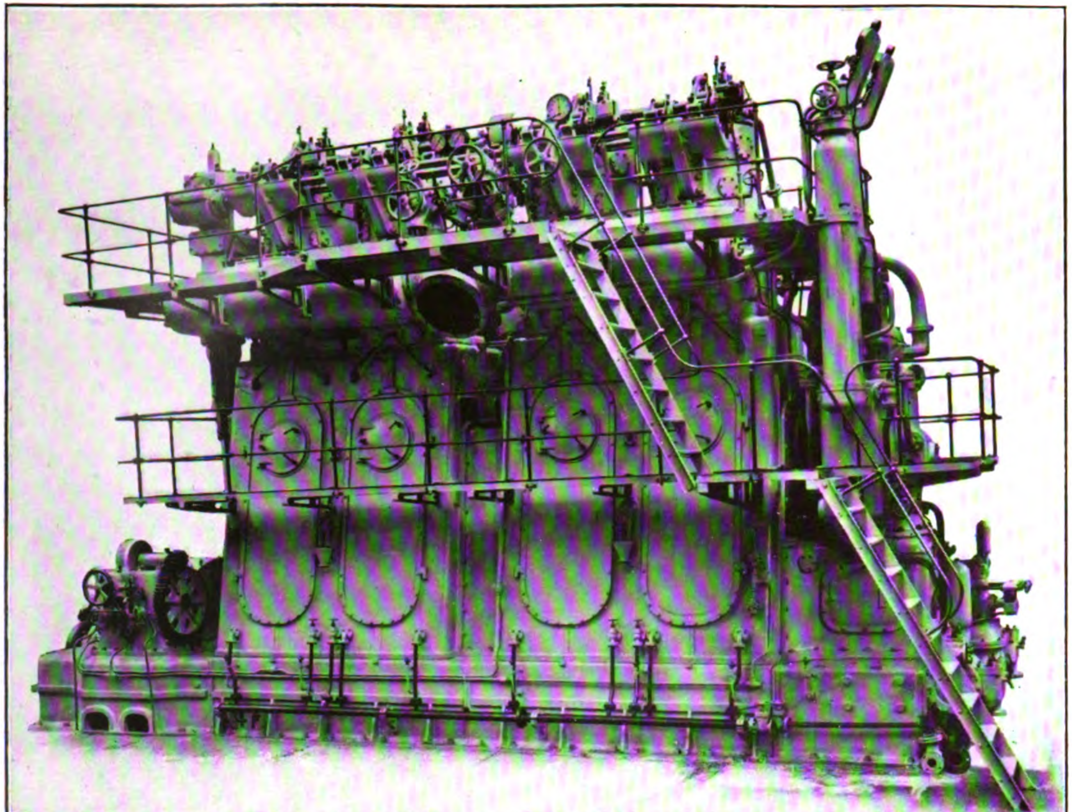
## HEAT TRANSMISSION IN CYLINDERS.

The maximum power which can be obtained from a given cylinder depends primarily on the limits of heat transfer from the working fluid through the metal surrounding the combustion space to the cooling medium. Attention is directed to the last column in the table indicating this quantity conveniently expressed in terms of pounds of fuel per square inch of piston area per hour, showing the divergence in published ratings in this respect, although it is suggested by the writer that the results in practice, so far, do not differ so widely, and that the quantity and rate of heat transfer continuously and successfully achieved are much nearer the lower than the higher figure.*

## AUXILIARIES FOR DIESEL SHIPS.

It is somewhat remarkable that whereas widely diverging views are held regarding the merits of the various types of Diesel engines applied for main propulsion, the system of driving the engine-room and ship's auxiliaries in motor ships bids fair to become standardised at an early date. Since no question of feed heating, etc., arises, full advantage has been taken of the electric motor, and the electric drive for all auxiliaries is becoming general. Electric steering with an hydraulic transmission system early justified adoption, and

* "The Present Position of the Marine Diesel Engine," by James Richardson, B.Sc., M.I.N.A., A.M.I.C.E., before the Institution of Engineers and Shipbuilders in Scotland, October 18, 1920.



1350 B.H.P. SULZER MARINE OIL ENGINE.

electric winches and capstans followed. The pumps in the engine-room are very suitably also electrically driven. As to the extent to which the main engine should be complete with all its own auxiliaries for supplying cooling water, lubricating oil, compressed air, etc., there is room for discussion; but, with the larger powered installation the practice of driving all but the fuel-injection air compressor by separate motors is general and will extend. High-pressure air compressors are difficult machines to drive, and for reliability slow speed and generous dimensions of driving gear are required. These conditions are well and economically met by driving from the main engine direct, which has the further advantage that the amount of compressed air required by the engine is, to a large extent, controlled automatically by the speed at which the engine runs.

Current for the electrically driven auxiliaries is naturally supplied by Diesel-driven generators, almost always of the four-cycle type, as being capable of starting up at the same notice as the main engines and requiring only the same qualities of fuel. The economy of this system is unrivalled. For steam heating, if required, a small donkey boiler is fitted. Steam auxiliaries, sometimes fitted, are found to detract seriously from the overall efficiency of the plant. With Diesel-driven oil tankers, where a large boiler plant must be carried, for steaming out the oil tanks etc., the auxiliaries are generally steam driven, although the extra cost of installing Diesel electric auxiliaries, as is sometimes done, and reserving the boilers for the specific purpose of steaming tanks, is justifiable on the ground that the extra outlay is compensated for by the greater economy of operation.

### The Internal Combustion Turbine.

The longed-for internal combustion turbine does not yet appear even on the horizon, although work on a fairly large scale is going forward on this problem in Germany. The Holzwarth gas turbine is known, but the results achieved and published are not encouraging. The difficulties still seem to be insuperable. The relative inefficiency and inevitable losses consequent upon the transference of the working medium from the separate compressor to the turbine, and the difficulties experienced and sure to be encountered with any available or known material when subjected continuously to the high temperature necessary for economy, are all barriers still to be surmounted.

In general, this chapter has dealt rather with the average low-powered cargo-carrier than with the relatively much smaller class of vessels of large size and power such as intermediate cargo and passenger and Atlantic liners, because it is felt that at the present time and for the immediate future the greatest efforts will be concentrated on that type of vessel of the maximum utility towards re-establishing the world's commerce on an economic basis.

Due to the slow progress that has been made with post-war construction, to the large percentage of vessels laid up, and construction

temporarily suspended, at the date of writing,—it is not yet possible to come to as many definite conclusions regarding the trend of post-war mercantile marine engineering as is desirable. During the course of the next year, however, a great many of the points now urgently calling for solution should be much further on the way towards becoming established practice, or, in the case of some of the present-day extremes, may be rejected as definitely unsuitable. The performance of a large number of most interesting ships, which will shortly be in operation, will be watched with the closest attention to discern to what extent they portend the future.

JAMES RICHARDSON.

## CHAPTER III.

### The Fall in Freights.

It is a fact, indeed by now a well-known commonplace which no one cares to dispute, that never since the advent of steam shipping has there been such a sudden and complete depression in freights as that which began in 1920 and still exists. At any time one of the most sensitive of industries, shipping anticipates rather than follows trade movements. It is like the barometer, which feels the change in the weather in advance.

In 1914, when the Great War burst over Europe, the shipping trade was suffering from a depression comparable in its severity with that of 1901–5. The first effect of the war was to depress freights still further, but that was merely a transitory wave which lasted over a few months of uncertainty. In 1915, war conditions began to exercise their usual influence on the shipping trade and with the increased demand for carrying tonnage and the increased risk in plying the high seas, freights commenced to rise and rose persistently as Germany's submarine campaign took its toll of Allied ships, until in 1918–1919 they had reached figures altogether unprecedented and made the high rates paid during the Crimean war look small indeed. This rise in freights anticipated the rise in prices generally, which followed in the later stages of the war and continued until recent times.

After the war had ended, and while prices of all other commodities were still rising, freights began to weaken in 1919, and in 1920 they tumbled down in such headlong fashion that the shipping trade performed a complete *volte face*, and in the brief space of twelve months fell from the peak of prosperity to the lowest depth of depression.

That depression, as all the world knows, still exists. Indeed, 1921 found freights even lower than in 1920, mainly as a result of the three months' coal stoppage. The depression came so swiftly that shipowners' calculations were all upset, and over 300 vessels, which had been contracted for with British shipbuilders during the post-war period of activity, were cancelled (under heavy penalties, for the most part) thereby reducing the shipbuilding industry to a state of depression coeval with that of shipping. In the same period, shipping values went all to pieces, assisted without doubt, by the enforced sale of German reparation tonnage in Allied countries. From some £20 to £24 a ton, good, second-hand cargo-steamers of over 5,000 tons d.w. fell to £7 or £8, and ex-German steamers in this category have been sold down to £3 a ton.

Improvement must necessarily be slow, for the world has an

excess of ten million tons over the pre-war period whilst the corresponding overseas trade is probably reduced by one half.

This is the simple explanation of the fact that more tonnage is at present laid up for want of employment than was ever before known.

### From Zenith to Zero.

This is a brief outline of the facts broadly stated. In examination of the situation it is not sufficient to indulge in mere generalities; it is necessary to be exact. Let us inquire, therefore, first how much freights have fallen actually, and then consider the causes and effects of the fall in their relation to trade and prices. As to the actual fall in freights, I am indebted to the editor of "The Compendium" for the figures in the table on page 239 showing the progressive fall in highest and lowest rates of freight from the zenith of the war period down to the zero of the depression this year, 1921, with the mean rate for each year. The table does not pretend to be wholly complete, but it is fairly representative of the chief departments of the freight market, and serves to illustrate the fall which has been experienced during the last two years. It may be added that these highest and lowest freights are based on actual freight market transactions reported from day to day, and they therefore represent literally the highest and lowest rates recorded in the market.

### Movement of the Index Number.

But the inquiry needs to be carried further than this statement of fact, if we are to consider freights in relation to trade and prices. The Chamber of Shipping, through its statistical department, has prepared an elaborate series of tables and charts, to which I have had access for the purpose of this article, thanks to the courtesy of the General Manager, Mr. H. M. Cleminson. From these documents let me reproduce the following representation of the course of freights from month to month by a single number on the lines of the several existing index numbers of wholesale prices. In constructing such an index number it was found necessary to decide (a) whether tramp rates only should be employed or whether liner rates should be included as well; (b) what should be considered as representative routes; (c) to what extent, if any, weighting should be employed, and the determination of appropriate weights; and (d) whether the method of arithmetical or geometrical averages should be employed.

As regards (a) the decision adopted was to employ the quotation for tramp voyages such as are published daily and weekly in the shipping papers and The Statist, and monthly in The Compendium. This decision was based on the fact that these rates respond more readily than liner rates to the daily fluctuations of supply and demand and on the further consideration that "in the long run, the general course of the freight market, operating primarily through tramp charterings, is reflected also in liner rates." * As regards (b) the choice of representative routes, a simple and concise division of

* J. A. Salter, "Allied Shipping Control" (1921), p. 12.

FREIGHTS IN 1920-21.

| Ports. | Highest war period freight. | 1920. Highest rate. | 1920. Lowest rate. | 1920. Mean. | 1921 (to August). Highest rate. | 1921 (to August). Lowest rate. | 1921 (to August). Mean. |
|---|---|---|---|---|---|---|---|
| Time charters— | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. | s. d. |
| General trade (12 months) . | 47 6 to 49 0 | 27 6 | 10 0 | 18 9 | 8 6 | 6 0 | 7 3 |
| Coal freights— | | | | | | | |
| Cardiff to River Plate . . . | 150 0 | 75 0 | 22 6 | 48 9 | 22 6 | 14 0 | 18 3 |
| „ „ Alexandria . . . | 140 0 | 82 6 | 20 0 | 51 3 | 27 6 | 16 0 | 21 9 |
| „ „ Las Palmas. . . | 56 3 | 38 9 | 17 6 | 28 1½ | 13 0 | 11 6 | 12 3 |
| „ „ St. Vincent . . . | 63 9 | 40 0 | 48 9 | 29 4½ | 14 0 | 11 6 | 12 9 |
| „ „ Barcelona . . . | 440 0* | 67 6 | 20 0 | 43 9 | 21 9 | 17 0 | 19 4½ |
| „ „ Gibraltar . . . | 100 0 | 52 6 | 12 6 | 32 6 | 13 6 | 9 0 | 11 3 |
| „ „ Lisbon . . . . | 100 0 | 50 6 | 17 0 | 33 9 | 16 6 | 11 0 | 13 9 |
| „ „ Rouen . . . . | 48 9* | 72 6 | 12 0 | 42 3 | 10 0 | 7 3 | 8 7½ |
| „ „ Havre . . . . | 48 9* | 60 0 | 12 0 | 36 0 | 9 6 | 6 6 | 8 0 |
| Tyne to Port Said . . . . | 200 0 | 75 0 | 17 6 | 46 3 | 17 6 | 14 0 | 15 9 |
| „ „ Genoa . . . . . | 100 0 | 87 6 | 17 6 | 52 6 | 22 6 | 14 0 | 18 3 |
| „ „ Bordeaux . . . | 78 0 | 47 6 | 10 0 | 28 9 | 10 0 | 8 3 | 9 1½ |
| „ „ London . . . . | 21 3 | 17 0 | 6 9 | 11 10½ | 8 6 | 5 9 | 7 1½ |
| „ „ Rouen . . . . . | 53 3* | 70 0 | 10 0 | 40 0 | 9 6 | 7 3 | 8 4½ |
| „ „ Gothenburg . . . | 220 kr. | 55 kr. | 24 kr. | 39½ kr. | 12 6 | 9 6 | 11 0 |
| Ore freights— | | | | | | | |
| Bilbao to Middlesbrough . | 40 0* | 39 6 | 15 0 | 27 6 | 16 0 | 6 0 | 11 0 |
| „ „ Tyne . . . . . . | 40 0* | 38 0 | 17 0 | 27 6 | 13 0 | 11 6 | 12 3 |
| Bordeaux to Bristol Channel. | 25 0 | 35 0 | 18 0 | 26 6 | 12 6 | 8 0 | 10 3 |
| Homeward freights— | | | | | | | |
| Rice Ports to U.K./Cont.. . | 600 0 | 180 0 | 75 0 | 127 6 | 65 0 | 32 6 | 48 9 |
| Bombay, d.w., do. . . | 410 0 | 155 0 | 45 0 | 100 0 | 50 0 | 20 0 | 45 0 |
| Java (sugar) do. . . | 300 0 | 200 0 | 70 0 | 135 0 | 72 6 | 35 0 | 53 9 |
| Australia to U.K., basis . . | 105 0† | 150 0 | 75 0 | 112 6 | 82 6 | 50 0 | 66 3 |
| Alexandria to London or Hull (per 60 c.f.) . . . . . . | 140 0 | 55 6 | 20 0 | 37 9 | 22 6 | 12 6 | 17 6 |
| River Plate to U.K./Cont. . | 280 0 | 215 0 | 35 0 | 125 0 | 60 0 | 27 6 | 43 9 |
| Sundsvall to East Coast . . | 250 0 | 250 0 | 100 0 | 175 0 | 105 0 | 60 0 | 82 6 |

the ocean routes to or from Europe is provided by the classification of ocean voyages according to twelve world divisions as given in Lloyd's List Weekly Summary. These divisions are: (1) Europe and West Africa; (2) Europe and South and West Africa and Madagascar; (3) Europe and Red Sea, India, etc.; (4) Europe and Java, China, Japan; (5) Europe and Australia and New Zealand; (6) Europe and West Coast North America; (7) Europe and West Coast South America; (7) Europe and Ascension, etc.; (9) Europe and Brazil; (10) Europe and Mexico and West Indies: (11) Europe and United States; (12) Europe and Canada. To this list should be added Trade in European waters, but no list of voyages in progress in this area is published.

So far as (c) weighting, is concerned, the ideal procedure would be to weight each quotation with the tonnage earning that freight. But this would be an exceedingly laborious task to perform even approximately. An alternative method is to use a greater number of component freights for the more important ocean divisions.

* Neutral steamers. † "Direction" rate.

A third possibility is to weight with the number of vessels engaged on the voyage in question. The method actually adopted for the 12 months of 1920 and the first 6 months of 1921 is that of using no directing weighting and employing more quotations on the more important routes. For the first 5 months of 1921, the index numbers have been recalculated, using the weights in the above table for the routes outside European waters. The change produced is very slight.

Geometrical averages have been employed throughout. The geometrical averages of the freight on each route for the 12 months of 1920 have been called 100 and the freights for each month of 1920 and the first 6 months of 1921 are expressed as percentages of these averages. Finally, the geometrical average of the freights on each of the 27 routes employed forms the index number of freights.

The use of the geometrical average will facilitate future comparisons when the base year is continually shifted.

It has not been possible to find a full series of freights representative of each of the thirteen ocean divisions mentioned above. The routes used are given below:—

European Waters:—(1) Alexandria to U.K.; (2) Bilbao to Cardiff; (3) Cardiff to St. Vincent; (4) Cardiff to Port Said; (5) Pit Props Baltic to U. K.; (6) Bilbao to Middlesbrough; (7) Bilbao to Clyde; (8) Bilbao to Bristol Channel; (9) Hornillo Bay to U.K.

Red Sea, Arabia and India:—(10) Calcutta to U.K./Cont.; (11) Karachi to U.K./Cont.; (12) Rice Ports to U.K./Cont.; (13) Bombay to U.K. d.w.

Java, China and Japan:—(14) Java to U.K./Cont.

Australia and New Zealand:—(15) Australia to U.K.

Argentine, Uruguay, etc.: (16) River Plate to U.K.; (17) River Plate to U.K. (Lower ports); (18) River Plate to Cont. (Lower ports); (19) San Lorenzo to U.K.; (20) San Lorenzo to Cont.

Brazil:—(21) Bahia Blanca to U.K.

United States, etc.:—(22) Northern Range to U.K.; (23) Northern Range to West Italy; (24) New York to Cont.; (25) Gulf Ports, grain, to U.K./Cont.; (26) Gulf Ports, timber, to U.K./Cont.

Canada:—(27) Canada to U.K., grain.

The table on pages 242 and 243 gives the index numbers and their component parts in detail.

## The Slump in Freights.

With the eye centred on the geometrical average for 1920—100—it will be seen almost at a glance how freights have fallen from their high to their low estate within the 18 months under review, while the summary figures for the different routes enable the reader to generalise in sufficient detail for most practical purposes. Thus, in the European trades, the average over the different trading routes was highest in June, 1920, at 146, but in July registered a sharp fall to 97, and in August and September to 77, rising momentarily in November to 90, since which time the fall has been consistent and rapid to 38 in April, 1921.

In the Red Sea, Arabian and Indian trades, the movements were similar except that the highest average—144—was reached earlier, in July, from which figure the descent was rapid to 26 in May, 1921, June showing a slight improvement to 31.

In the Far Eastern trade, from a highest average of 153 in January, 1920, there was a big drop in February to 101, a slight rally from April to July, and a sharp descent down to 28 in May, 1921, while in the Australian trade, from a highest average of 146 in March, there is a similar descent to 37 in May, 1921.

Turning to the Western Hemisphere, we find that freights followed practically the same course. In the Argentine trade, a highest average of 173 in March, 1921, was followed by an equally marked descent to 34 in February, followed by a slight rise to 55 in May.

In the United States trade, the fall is almost without a break from 145 in January, 1920, to 36 in March, 1921, since which a slight recovery to 43 is registered in May and June.

In the Canadian grain trade, the highest rate naturally was attained later, owing to the seasonal character of the business; in June it was 113, since which it fell persistently to 55 in June, 1921.

Taken over all, the geometrical average was highest in March, 1920, at 141, from which it fell to 84 in August—September, recovered to 93 in October, only to fall to 80 in November and to 58 in December, since which month it dropped to 37 in March, 1921, and rallied to 43 in June.

## Signs of Recovery.

It will be seen from this interesting table that with comparatively unimportant exceptions here and there, average freights have fallen from a highest figure, usually about March, 1920, to a lowest, usually in March, 1921, and that since that month, a slightly upward tendency has supervened in practically every trade. It looks, therefore, as though the lowest point of the depression has been plumbed, and that recovery, however slow, has now commenced. It were worth while to labour over these figures to arrive at this comforting conclusion.

As the highest averages in nearly every case were reached in March, 1920, and as March—April of that year, with singular uniformity, marked the beginning of the decline, which ended in the unexampled depression of 1921, it is necessary to cast our minds back to the movements in evidence in the spring of last year. Turning to "The Compendium" for April, 1920, I find the following:

"Every shipowner knows that freights are on the down grade, and would be below their present figures but for the reduced carrying power of steamers owing to the terrible muddle of our railway transport system and congestion at the docks, and, I must add, the infamous price of bunker coals resulting from coal control mismanagement. If we could once secure full work out of the ships afloat and reasonably cheap bunker coals, freights would soon return to a lower level, and prices of foodstuffs and raw materials would fall. Of course, the chief reason for the fall is the steady —almost rapid—increase in the supply of new tonnage. Lloyd's Register returns for the quarter ending March 31 shed additional light on the subject. The fact that there are now building in United Kingdom yards, 3,394,425 tons is very significant of our increasing productive capacity. It is 1,140,000 tons more than the quantity in hand twelve months ago, and it is the largest tonnage of merchant shipping ever recorded as on the stocks at one time. But this is not all. In spite of the marked falling off in the United States, the tonnage building abroad is returned by Lloyd's Register as 4,547,525 tons, so that the world's total is now up to 7,941,950 tons, or

FREIGHTS IN

GEOMETRICAL AVERAGE OF MONTHLY

| | 1920. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Jan. | Feb. | March. | April. | May. | June. | July. | Aug. | Sept. |
| 1. Alexandria to U.K, . . . . | 118 | 118 | — | 155 | 132 | 111 | 86 | 72 | 77 |
| 2. Bilbao to Cardiff . . . . . | — | — | — | — | — | — | — | 102 | 100 |
| 3. Cardiff to St. Vincent . . . | 127 | 137 | 127 | 117 | 113 | 111 | 92 | 74 | 71 |
| 4. Cardiff to Port Said . . . . | 140 | 178 | 173 | 172 | 166 | 135 | 92 | 69 | 67 |
| 5. Pit Props Baltic to U.K. . . | | — | — | 153 | 160 | 135 | 116 | 74 | 71 |
| 6. Bilbao to Middlesbro' . . . | 119 | 135 | 153 | 136 | 113 | 110 | 101 | 70 | 70 |
| 7. Bilbao to Clyde . . . . . | 112 | 143 | 151 | 136 | 116 | 115 | 99 | 77 | 75 |
| 8. Bilbao to Bristol Channel . . | 121 | 126 | 128 | 117 | 113 | 106 | 96 | 83 | 83 |
| 9. Hornillo Bay to U.K. . . . | 108 | 141 | 137 | 146 | 127 | 108 | 94 | 76 | 79 |
| EUROPEAN WATERS . . . . | 120 | 139 | 144 | 140 | 113 | 146 | 97 | 77 | 77 |
| 10. Calcutta to U.K./Cont. . . . | 124 | 125 | 125 | 112 | — | 84 | — | — | 70 |
| 11. Karachi to U.K./Cont. . . . | 126 | 153 | 131 | 114 | 126 | 117 | — | 66 | — |
| 12. Rice Ports to U.K./Cont. . . | 151 | 142 | — | — | 117 | 103 | 94 | 96 | 85 |
| 13. Bombay to U.K. (d.w.) . . . | 123 | 158 | 131 | 112 | 120 | 112 | 98 | 73 | 87 |
| RED SEA, ARABIA, INDIA . . | 131 | 144 | 129 | 113 | 121 | 103 | 96 | 77 | 80 |
| 14. FAR EAST, JAVA TO U.K./CONT.. | 153 | 101 | 77 | 129 | 117 | 107 | 109 | 89 | — |
| 15. AUSTRALASIA TO U.K. . . . | 89 | 145 | 146 | 116 | 107 | 116 | 85 | 90 | 88 |
| 16. River Plate to U.K. . . . . | 172 | 174 | 169 | 124 | 107 | 99 | 81 | 78 | 94 |
| 17. River Plate to U.K. (L. Ports). | 67 | 198 | 189 | 158 | — | — | 86 | 86 | — |
| 18. River Plate to Cont. (L. Ports). | 189 | 172 | 173 | 140 | 108 | 93 | 68 | 89 | 77 |
| 19. San Lorenzo to U.K. . . . | 74 | 74 | 162 | 129 | 129 | 115 | 97 | 96 | 110 |
| 20. San Lorenzo to Cont. . . . | 217 | — | — | — | 134 | 114 | 88 | 88 | 114 |
| ARGENTINE, URUGUAY, ETC. . | 128 | 145 | 173 | 137 | 119 | 105 | 83 | 88 | 96 |
| 21. BRAZIL, BAHIA BLANCA to U.K. | 74 | 127 | — | 127 | — | 126 | — | 96 | — |
| 22. Northern Range to U.K. . . | 159 | 152 | — | — | 145 | 120 | 112 | 85 | 95 |
| 23. Northern Range to W. Italy . | 159 | 141 | 137 | 133 | 129 | 112 | — | 85 | 84 |
| 24. New York to Cont. . . . . | 144 | — | — | — | — | 129 | — | 97 | — |
| 25. Gulf Ports, grain to U.K./Cont. | — | — | — | 96 | 96 | 106 | 96 | 101 | 102 |
| 26. Gulf Ports, timber to U.K./Cont. | 121 | 121 | 124 | 110 | 112 | 121 | 113 | — | 86 |
| UNITED STATES . . . . . | 145 | 137 | 130 | 112 | 119 | 117 | 107 | 92 | 91 |
| 27. Canada to U.K., grain . . . | 90 | — | — | 95 | 108 | 113 | 99 | 97 | — |
| Geometrical average, 1–27 . . | 123 | 138 | 141 | 127 | 121 | 112 | 95 | 84 | 84 |

81,000 tons more than it was three months ago. "The Times" estimates that the tonnage of the world now afloat and in service is 49,400,000, or 4,000,000 tons more than before the war. Thus we have now 4,000,000 tons increase, plus nearly 4,000,000 tons of British and over 4,000,000 tons of foreign-built tonnage to come into trade this year, by the end of which the world may safely calculate on having 12,000,000 tons more shipping afloat than when war broke out. With so much more carrying power at command and in sight, it is impossible that freights can long remain at their prevailing high figures."

This was written before international trade had commenced its slide downwards and while commodity prices were still at practically

1920 AND 1921.

RATES FOR 1920—100.

| Oct. | Nov. | Dec. | Yearly average, 1920. | 1921. Jan. | Feb. | March. | April. | May. | June. | Freight per ton or standard. Geometrical average for 1920 in shillings or dollars. |
|---|---|---|---|---|---|---|---|---|---|---|
| 94 | 104 | 64 | 100 | 49 | 40 | 39 | 38 | 39 | — | 35 885 |
| 113 | 103 | 86 | 100 | 67 | 52 | 50 | — | — | — | 16·001 |
| 89 | 61 | 60 | 100 | 42 | 39 | 43 | 39 | — | — | 31·028 |
| 84 | 59 | 35 | 100 | 34 | 40 | 40 | 40 | — | — | 43·590 |
| — | — | — | 100 | — | — | — | — | — | — | 140·25 (standard) |
| 92 | 75 | 68 | 100 | 55 | 35 | 36 | — | — | — | 24·736 |
| 79 | 77 | 57 | 100 | 52 | 43 | 32 | 33 | — | — | 25·430 |
| 94 | 82 | 72 | 100 | 61 | 40 | 46 | — | — | — | 19·762 |
| 79 | 79 | 67 | 100 | 45 | — | 37 | — | — | — | 24 590 |
| 90 | 79 | 63 | — | 50 | 41 | 40 | 38 | 39 | — | — |
| 77 | — | — | 100 | — | — | — | — | — | — | 142·99 |
| 103 | 70 | 50 | 100 | 41 | 27 | 23 | 26 | 23 | 29 | 87·549 |
| 95 | 85 | 63 | 100 | — | — | 36 | 31 | 31 | 35 | 119·47 |
| 88 | 84 | 57 | 100 | 50 | 34 | 27 | 25 | 24 | 29 | 89·434 |
| 90 | 79 | 56 | — | 45 | 30 | 28 | 27 | 26 | 31 | — |
| 97 | — | 56 | 100 | 45 | 30 | 29 | — | 28 | 37 | 124·08 |
| 98 | 96 | 71 | 100 | 57 | 47 | 44 | 40 | 37 | 40 | 140 19 |
| 83 | 62 | 41 | 100 | 36 | 34 | 32 | 38 | 49 | 49 | 108·97 |
| 94 | 72 | 51 | 100 | 39 | 31 | 35 | 42 | 58 | 54 | 93·373 |
| 86 | 79 | 39 | 100 | 27 | 28 | 32 | 35 | — | 47 | 106·97 |
| 103 | 96 | 57 | 100 | 44 | 40 | 40 | 46 | 59 | 54 | 87·269 |
| 93 | 82 | 49 | 100 | 40 | 37 | 39 | 41 | — | 49 | 97·683 |
| 92 | 77 | 47 | — | 37 | 34 | 35 | 40 | 55 | 51 | — |
| 113 | 102 | 59 | 100 | 51 | 44 | 40 | 44 | 59 | 58 | 88·265 |
| 85 | 69 | 45 | 100 | 33 | 31 | 31 | 31 | — | 41 | 14·160$ |
| 82 | 69 | 43 | 100 | 37 | 34 | 33 | 36 | 36 | 35 | 16·716$ |
| 127 | 68 | 64 | 100 | 33 | 29 | 28 | 40 | — | — | 13·162$ |
| 124 | 108 | 79 | 100 | 66 | 56 | 60 | 60 | 62 | 61 | 12·531$ |
| 82 | 74 | 63 | 100 | 56 | 45 | 35 | 37 | 35 | 40 | 408 (standard) |
| 98 | 76 | 57 | — | 43 | 38 | 36 | 40 | 43 | 43 | — |
| 99 | — | — | 100 | — | — | 59 | 58 | 56 | 55 | 11·079 |
| 93 | 80 | 58 | 100 | 45 | 38 | 37 | 39 | 40 | 43 | — |

the highest figures. In point of fact, the excess of tonnage did not quite reach 12,000,000 tons for the reason that shipbuilding was soon to receive a rude check by the wholesale cancelling of contracts, while the rate of production remained abnormally low, but it did reach well over 10,000,000 tons, as we shall see. What was apparent in March—April, 1920, was that freights had commenced to fall owing to a combination of causes, of which two may be considered primary. They were (1) the world effort to make good the war losses of shipping, led by the United States, and (2) the great restriction in

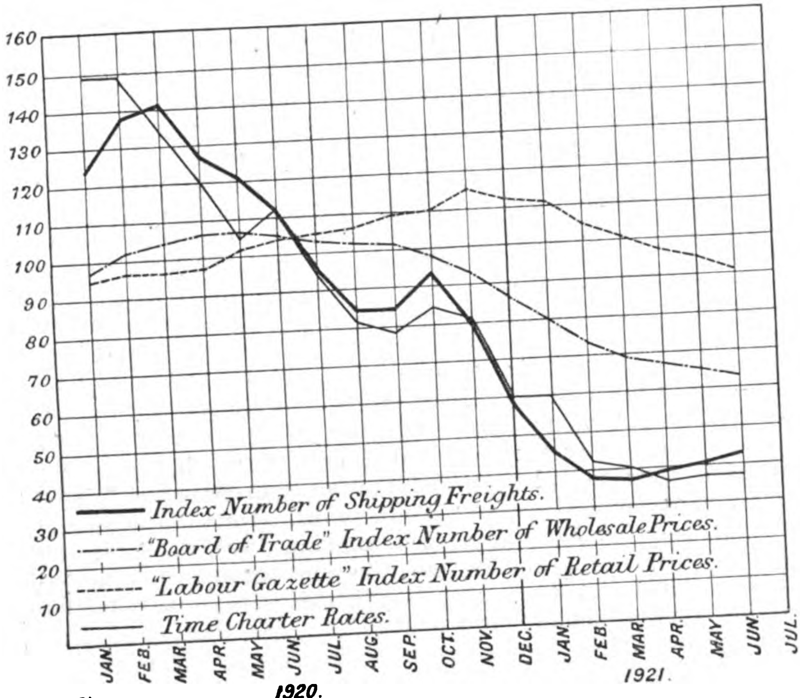
world trade, which supervened in 1919 as a result of unfavourable post-war conditions. It is, perhaps, unnecessary to discuss these causes in much detail, since they are now accepted as incontrovertible facts, but it may be said that the effort to replace the lost tonnage was more than successful. All the world knows how the United States entered upon a great emergency shipbuilding programme, which in five years increased the American mercantile marine by ten and a half million tons. Also, how construction in the British yards grew until it overtopped three million tons in 1920, and reached nearly 4,000,000 tons in March, 1921. Australia and Canada, like the United States, started State shipbuilding programmes, and France and Italy likewise proceeded to repair their wasted fleets by Government assisted building, as also did Japan, while even far-away China unexpectedly entered the lists as a tonnage producer. The net result at the end of June, 1921, according to Lloyd's Register statistical tables, is that the world tonnage of seagoing iron and steel steamers amounted to 54,217,000 tons, as against 42,514,000 tons in June, 1914, an increase of 11,703,000 tons. The shortage of tonnage caused by Germany's submarine campaign was, therefore, purely temporary, being so quickly overtaken by the intensive production of the world's shipyards that to-day the world's carrying fleet is eleven million tons in excess of 1914.

## Trade and Shipping.

Now, it may be at once admitted that had the trade of the world maintained its first post-war impetus, this excess of tonnage would have been, in effect, no excess at all, but would have represented simply the increase necessary to keep pace with the normal growth of world trade. But while the carrying tonnage afloat exceeds the pre-war quantity by eleven million tons, the quantity of world trade reckoned in tonnage is much below the pre-war level, and consequently these eleven million tons count as excess tonnage which world trade, for the time being, cannot absorb. It is this position which is the direct cause of the freight depression. The remedy is obvious. Only improvement in world trade can restore the balance. As soon as that improvement materialises, freights will begin to rise and shipping will throw off its depression.

But until trade does thus improve, there are palliatives which may be applied to the shipping trade with advantage. The first, naturally, is reduced, or for a time, even suspended production of new tonnage; the second is the weeding out of obsolete and uneconomical ships from the existing world fleet; and the third is a reduction in working costs to figures commensurate with the existing low values of freights. All three palliatives are in process of application. The check to shipbuilding has commenced. In America, State shipbuilding has come to an end. In our own country, the shipbuilding industry is suffering from a depression so acute that the yards are kept going simply on the remnant of old orders which have not been cancelled. Elsewhere the whole tendency now is to curtail new production.

As to the second palliative, I have estimated that there are




(7037.S.)

INDEX NUMBERS.

| | Freights. | Time charter. | B. of T. wholesale prices. | "Labour Gazette" retail prices. | Freights. Weighted by Table I. (extra European) routes only. |
|---|---|---|---|---|---|
| **1920.** | | | | | |
| January | 123 | 149 | 97 | 94 | — |
| February | 138 | 149 | 102 | 96 | — |
| March | 141 | 134 | 104 | 96 | — |
| April | 127 | 120 | 106 | 97 | — |
| May | 121 | 105 | 106 | 101 | — |
| June | 112 | 112 | 105 | 104 | — |
| July | 95 | 94 | 103 | 105 | — |
| August | 84 | 81 | 102 | 106 | — |
| September | 84 | 78 | 101 | 109 | — |
| October | 94 | 84 | 98 | 110 | — |
| November | 80 | 81 | 93 | 115 | — |
| December | 58 | 60 | 86 | 112 | — |
| 1920 | 100 | 100 | 100 | 100 | — |
| **1921.** | | | | | |
| January | 45 | 60 | 80 | 111 | 43 |
| February | 38 | 42 | 73 | 105 | 37 |
| March | 37 | 40 | 69 | 101 | 36 |
| April | 39 | 36 | 67 | 97 | 40 |
| May | 40 | 37 | 65 | 95 | 42 |
| June | 43 | 37 | 64 | 91 | — |

The last column shows the small effect produced by weighting, and a comparison of the first two columns shows that the time charter rate is a fairly reliable index of the state of the freight market, as indeed it is commonly recognised to be.

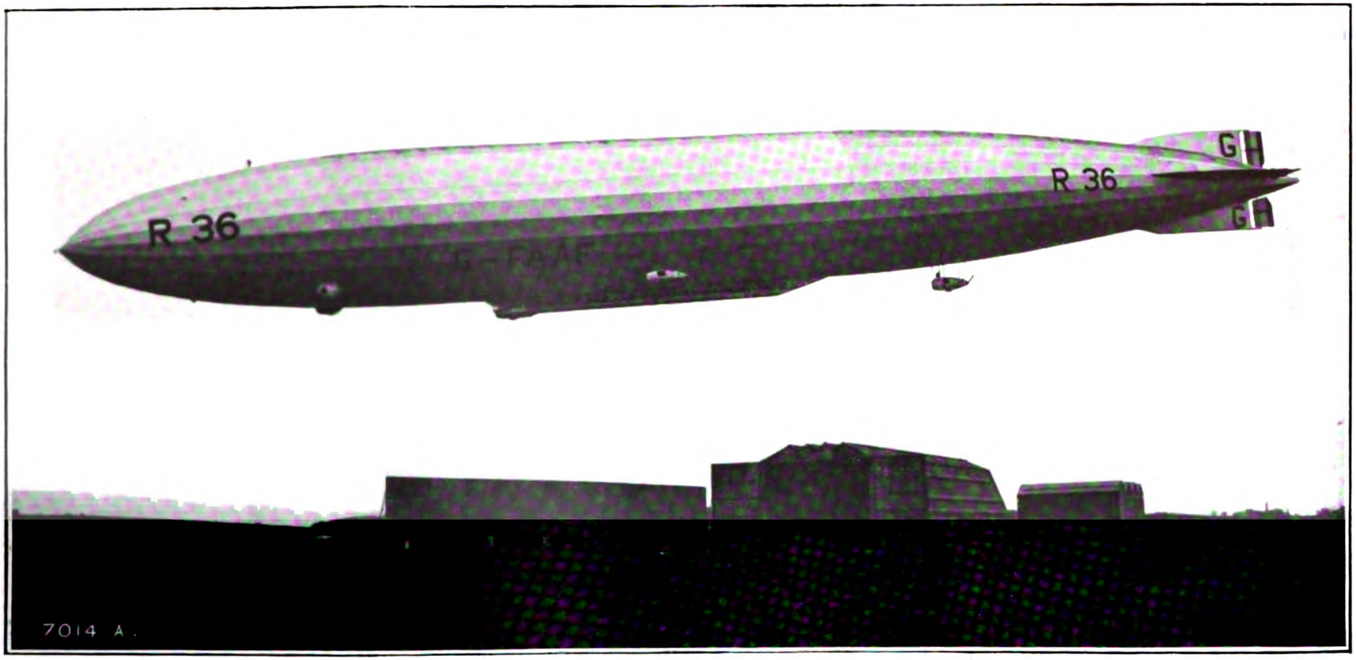
probably $1\frac{1}{2}$ million tons of obsolete vessels which would have been scrapped years ago but for the war, and cannot be much longer retained afloat. But on this point let me quote Sir Owen Philipps, president of the Chamber of Shipping, who said in his presidential address to that body:—

"Although in certain trades some vessels may continue to do economic work for long periods, the normal life of a vessel is only about 20 years, and, therefore, 5 per cent. of the total tonnage of the world, or say, over three million tons of world shipping, ought to be broken up every year. There is at the present time, an unusually large number of old vessels of all countries afloat, which, owing to their age, construction, or design, must be unsuitable to compete in the strenuous times that lie ahead, and in the interests both of shipowners and shipbuilders, and all their employees, I trust the industry of the shipbreaker will again become active."

As to the third palliative—the necessity for reducing working costs—a movement in that direction is gathering weight. Bunker coals have lately suffered a sharp decline, and there is now a substantial saving in stores and insurance; loading and discharging costs have also begun to fall since the dockers' and transport workers' wages were revised. In the matter of wages, substantial reductions have been effected by owners in Great Britain, Norway, and the United States. In Great Britain, the seamen and firemen have consented by ballot to a reduction which is now in operation. Working costs are coming down, slowly no doubt, but surely enough to warrant the expectation of further reductions ere long, though it may be taken for granted that they will not again return to the level which ruled just before the war.

And now, having traced the course of freights from prosperity to adversity, and having considered the causes of the depression, let us for a moment see what relation the fall in freights has borne to wholesale and retail prices of commodities. The Chamber of Shipping statistics have been extended to cover this point and the table on page 245 compares the index number of shipping freights with the Board of Trade Index number of wholesale prices and with the "Labour Gazette" Index number of retail prices, and with time charter rates. It will be seen that the index number of freights shows a marked downward curve from March, 1920, to September, 1920, rose a little in October and then fell sharply to March of this year, rising ever so slightly from March to June. On the other hand, wholesale and retail prices did not follow the upward curve in freights and did not fall to the same extent, though the fall in wholesale prices since September has been much more decided than that of retail prices, which even up to June stood at 91, while wholesale prices were down to 64, and freights to 43, with time charter rates at 37. It is an old contention of mine that freights do not govern prices to the consumer to any marked extent, and this Chamber of Shipping table certainly supports that view, for it shows that retail prices neither rose appreciably with the rise, nor fell appreciably with the fall in freights, though wholesale prices did follow remotely the rise and more decidedly the fall in freights.

W. J. NOBLE.




PASSENGER-CARRYING AIRSHIP R 36 (G–FAAF).

Constructed by Messrs. W. Beardmore & Co., Ltd., Inchinnan, N.B.

# CHAPTER IV.

## Commercial Airships.

Experience with railway trains, steamships, and motor cars has shown that the greatest obstacles to the introduction of improved means of transport are mainly of an artificial nature arising more from legal obstruction, financial difficulties, and natural prejudices than from any technical or other inherent drawback in the new system itself. Such obstacles have been duly overcome in the cases cited and doubtless will also be removed in the case of aerial transport, now in the early stages of development, since the value of high-speed communications is more fully appreciated than was formerly the case.

To no country is the development of transport facilities of more vital importance than one forming the centre of an Empire widely scattered over all parts of the globe, and for this reason it is highly desirable that Great Britain should take up and maintain the same position with regard to aerial transport as she has done and still does in connection with maritime transport. In securing this position valuable assistance can undoubtedly be given by the shipping section of the community, whose wide experience in sea transport problems would enable them to deal satisfactorily with the somewhat similar problems in connection with aerial transport. Much of their existing organisation could also be equally well employed for either system of transport. It is for the purpose of calling the attention of shipping interests to the present position and future possibilities of aerial transport that the following notes have been collected.

### Development of Passenger-Carrying Airships.

In connection with the transport of passengers and goods by aircraft of the lighter-than-air type, a striking feature is that of all airship building countries Great Britain alone has not yet employed them for commercial work. The earliest case on record of an airship being used for passenger carrying for profit was that of the French non-rigid named the "Ville-de-Nancy," which was used to carry out a regular programme of passenger trips at the Exposition held at Nancy in 1909. This ship was of the "Astra" type, of 120,000 cubic feet capacity. A larger ship of 160,000 cubic feet of the same type, named the "Ville-de-Pau," was used for passenger flights at Pau and Lucerne in 1910 and 1911, and made a total of 273 trips and carried 2,950 passengers.

The Luft-Fahrzeug-Gesellshaft in Germany built several non-rigids of the "Parseval" type which were operated for pleasure trips on a profit-making scale by special companies formed for the purpose.

Airship No. PL. 16, named "Stollwerck," of 300,000 cubic feet capacity, was in regular service for passenger pleasure trips and advertising purposes from June, 1910, to June, 1912. She was used particularly for flights from Munich over the Swiss lakes to Lucerne, and was also flown periodically in the summer season at Berlin. She carried up to twenty passengers at a time and made over 250 trips, carrying a total of 2,300 passengers for a total of 15,000 miles' flying, after which the vessel was taken over by the German Government.

The extent to which Zeppelin airships were developed for passenger carrying in Germany before the war has been hardly realised in this country. The Deutsche Luftschiffahrt A.G. (the German Air Travel Co.), known as the "Delag" Co., was formed in 1909 for the exploitation of Zeppelin airships for commercial purposes, and was mainly financed and managed by the Hamburg-America Line. During the period 1910–1914 it operated passenger excursions, and, to a limited extent, regular town-to-town services between Potsdam, Liepsig, Friedrichshafen, Baden, Frankfurt, and Hamburg. Six airships were built for this service, named: "Deutschland" I. and II., "Schwaben," "Viktoria-Luise," "Hansa," and "Sachsen." These ships were all of practically the same design and size and had a gas capacity of about 700,000 cubic feet and a length of about 460 feet.

During the period 1910 to 1913 there were usually three ships in commission at a time, and between them these ships made over 1,300 flights and carried more than 26,000 passengers for a total distance of over 87,500 miles, without a single passenger being killed or even injured. The "Viktoria-Luise" is known to have made 200 trips on 250 consecutive days, and, during 1913, flights were made on 350 days out of 365.

These airships had accommodation for 20 passengers in a saloon built on underneath the hull, and provided with comfortable seats and tables so arranged that all passengers could have a good outlook. The company confined its operations mainly to short pleasure excursions of two or three hours' duration, and also ran periodic trips between Berlin, Frankfurt, Dresden, and Leipsig. Aerodromes and sheds for the use of the "Delag" were built at Potsdam, Hamburg, Leipsig, Dresden, Munich, Frankfurt, and Baden-Baden, some being constructed by the company and the others by the municipalities of the cities concerned. The company charged at the rate of 100 marks (or £5) for a trip, and made a good profit on the working, in addition to a subsidy received from the Government for training military and naval airship crews. At the outbreak of war the "Viktoria-Luise," "Hansa," and "Sachsen" were taken over by the German Navy and used as training ships until they became obsolete owing to the rapid improvement in design attained with new construction.

Their pre-war experience had so impressed the "Delag" with the commercial possibilities of rigid airships that immediately after the conclusion of the Armistice they commissioned the Zeppelin Construction Co. to build a passenger airship to embody all the

improvements in design developed during the war. This airship, named the "Bodensee," which is much smaller than the airships built during the war, has a gas capacity of 700,000 cubic feet, with a length of 400 feet, and a diameter of 61 feet. With four engines of 260 B.H.P. each, she is capable of maintaining a speed of 75 miles an hour for 12 hours and so covering a distance of 900 miles with a load of 5 tons of passengers or mails. The passenger space is in a saloon car built on under the hull, and has accommodation for 30 people.

The vessel was completed and put into service in August, 1919, and operated a regular daily service between Berlin, Munich and Friedrichshafen during August, September and October, making the trip of 375 miles from Friedrichshafen to Berlin in 6 hours. During the suspension of the German railways in November, due to revolutionary troubles, over 1 ton of mails per day were conveyed regularly for several weeks until the resumption of rail traffic. The fare charged for the trip between Berlin and Friedrichshafen was 400 marks (on pre-war exchange about £20 and at the time equal to about £3), including meals *en route* and luggage up to 30 lbs. carried free and over this amount at 2 marks per pound.

Several demonstration trips between Berlin and Stockholm were carried out with the object of obtaining Swedish interest in the establishment of a regular service between that country and Berlin. At the end of November the "Bodensee" sustained slight damage when landing at Staaken during a heavy snowstorm, but was flown to the Zeppelin works for repairs. She was ready again for service in January, 1920, but by that time the Allied Commission of Control had prohibited all commercial flying in Germany. This airship, and a sister ship named the "Nordstirn," which was practically completed, had therefore to be taken out of service, deflated and suspended in their sheds until the period of inactivity enforced by the Peace Treaty has elapsed.

During the time she was in commission the "Bodensee" made 103 trips, spending a total time of 533 hours in the air, and carried 2,380 passengers without a single accident to any one either among passengers or crew. She also carried 10,000 lbs. of mails and 66,000 lbs. of passengers' luggage.

The fact that this German concern, both before and after the war, carried thousands of passengers without injury to any one amply demonstrates the safety of airship travel and forms a unique record in the annals of rapid transport.

The Italians have carried out experimental passenger-carrying services between Milan and Venice with Forlanini semi-rigids, but in Great Britain little has yet been done towards the development of airship transport.

The naval rigid airship R36, built by Messrs. Beardmore, has, however, been converted into a passenger carrier by the Air Ministry for demonstration purposes, and was delivered to the Airship Experimental Station at Pulham in April, 1921. She will probably be used for an experimental service to Egypt.

Data relating to the R36 and to the French, German and Italian airships previously mentioned are given in the table on p. 250.

## Past and Present Passenger Airships.

| Name and type. | Builder. | Owner. | Period in service. | Gas capacity. Cubic feet. | Number of passengers accommodated. | Speed. Miles per hour. | Endurance with full load. Miles. | Service Record. | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | No. of flights. | No. of passengers carried. | |
| "Ville-de-Nancy," Semi-rigid | "Astra" Co., France | Campagnie Generale Transaërienne | 1909 | 120,000 | 6 | 28 | 100 | Not known | | — |
| "Ville-de-Pau," Semi-rigid | Do. | Do. | 4/1910—7/1911 | 160,000 | 6 | 26 | 150 | 273 | 2,950 | — |
| "Stollwerck," Non-rigid | Luftfahrzeug-ges., Germany | L.F.G. | 6/1910—9/1912 | 320,000 | 10 | 37 | 250 | 250 | 2,300 | Afterwards taken over by German Army |
| "Charlotte," Non-rigid | Do. | Rheinsche-West-falische Flug. Gesell. | 1912 | 310,000 | 10 | 34 | 200 | Not known | | — |
| "Schwaben," Rigid | Zeppelin Co. | D.E.L.A.G. | 6/1911—6/1912 | 630,000 | 20 | 47 | 600 | 230 | 4,622 | Wrecked when entering her shed during a gale |
| "Viktoria-Luise," Rigid | Do. | Do. | 2/1912—7/1914 | 660,000 | 20 | 50 | 600 | 384 | 8,134 | Used as Training Ship for German Navy during War |
| "Hansa," Rigid | Do. | Do. | 7/1912—7/1914 | 660,000 | 20 | 50 | 600 | 297 | 6,217 | Do. |
| "Sachsen," Rigid | Do. | Do. | 5/1912—7/1914 | 790,000 | 25 | 48 | 700 | 206 | 2,698 | Do. |
| "Bodensee," Rigid | Do. | Do. | 20/8/19—11/19 | 706,300 | 80 | 80 | 900 | 103 in 80 days | 2,380 | Prohibited from further flying after Jan. 1920, by Peace Treaty restrictions |
| "Nordstirn," Rigid | Do. | Do. | Not yet in service. | 794,600 | 30 | 80 | 1,000 | — | — | Completed but prohibited from use by the Peace Treaty restrictions |
| "Roma," Semi-Rigid | Brigata Specialisti, Rome | Sold to U.S.A. Govt. | — | 1,200,000 | 25 | 75 | 1,000 | — | — | First trial trip carrying passengers |
| R36, Rigid | Beardmore, Glasgow | Air Ministry | 4/1921 | 2,196,000 | 50 | 65 | 1,750 | — | — | Naval airship converted to passenger ship by Air Ministry for demonstration purposes |

### AIRSHIP ROUTES.

It is on the great ocean routes of the world that the airship will have its opportunity as a commercial means of transport, and particularly for communication between Europe and America, India, Australia, South Africa, and the Far East. On these long-distance routes the possibility of saving time will be so great that no difficulty is likely to be encountered in securing the relatively small proportion of traffic necessary to justify a regular airship service.

The speed of the rigid airship of to-day is 65 or 70 miles per hour, but with the larger size of ship specially designed for commercial purposes there will be no difficulty in attaining a full speed of at least 80 miles per hour, which would enable an average speed of 60 miles per hour to be maintained on long voyages without difficulty. The fastest ocean steamships of the world cross the Atlantic at a speed of 25 knots (28 miles per hour), but this speed is exceptional and is only reached by a few liners of the largest size; 18 knots (21·5 miles per hour) is, if anything, rather higher than the usual speed for ocean liners in general. This speed cannot be much exceeded with present means of propulsion without sacrificing space and displacement to engines and fuel to such an extent that the consequent reduction in passenger and cargo-carrying capacity would render running costs prohibitive.

It is only between great centres of population, such as Europe and the United States, that the volume of traffic is large enough to justify the great size of steamship necessary to maintain a speed of even 20 knots, with the consequence that on such routes as from Europe to India, Australia, South Africa, and the Far East, where the amount of passenger traffic is relatively small, it would be commercially impossible to run ships at anything approaching this speed. In the case of airships of even the largest sizes contemplated, the number of passengers and the weight of mails required to maintain a regular service is relatively small, and they could probably obtain sufficient traffic to be run on routes where an average speed of more than 18 knots (or 21·5 miles per hour) by steamship would be impracticable. It should therefore be possible to reduce the time taken for a given voyage to about one-third of its present length.

### POSSIBLE ROUTES.

The following routes seem most suitable for the development of airship services: England to Egypt, calling at Marseilles (2,350 miles); Egypt to India, calling at Basra, Bombay and Colombo (3,700 miles); India to Australia, calling at Singapore, Perth, Melbourne, and Sydney (6,670 miles); Singapore to Japan, calling at Hong-Kong and Tokio (3,400 miles); Egypt to South Africa, calling at Mombasa, Johannesburg, and Capetown (4,900 miles); England to West Africa and South America, calling at Lisbon, Sierra Leone, Rio de Janeiro and Buenos Aires (7,100 miles); England to New York, calling at Lisbon on the westward route (4,250 miles) and proceeding direct on the eastward route (3,500 miles); New York to San

Francisco, calling at St. Louis (2,800 miles); and San Francisco to Australia, calling at Honolulu and Fiji (7,500 miles).

Winds will, of course, have considerable influence on the actual routes to be followed. As is well known, there are at sea level, between fairly well-defined latitudes, permanent and prevailing winds of generally constant direction and force of which advantage can be taken by suitably laying out the courses to be followed and varying them according to the season. It is now the opinion of meteorologists and experienced airship pilots that, when routes are laid out in accordance with meteorological information, the passage over long sea routes will be materially shortened by taking advantage of prevailing and local winds, and that on the average 10 to 15 miles per hour may be added to the speed relatively to the earth.

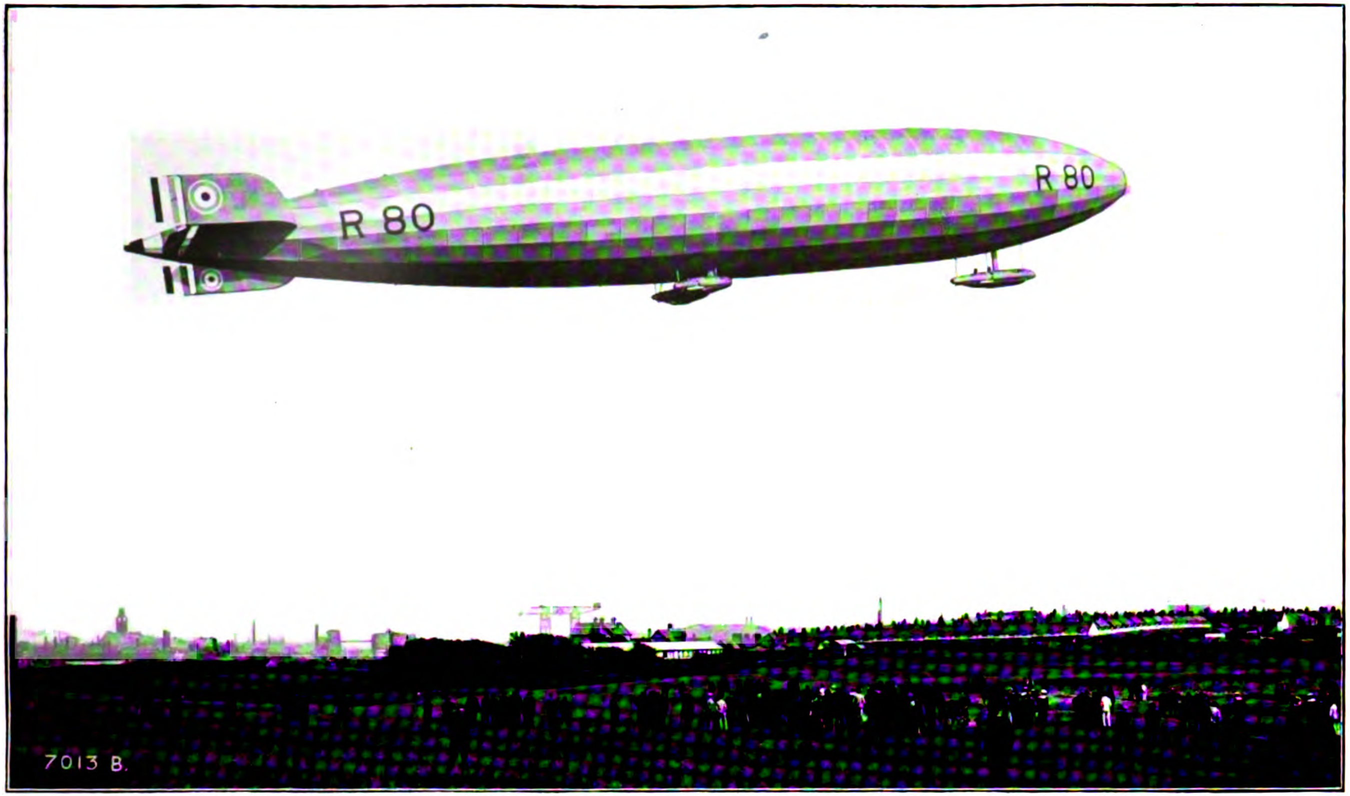
It must not be forgotten that the safety and regularity of steamship services are largely due to the development of ports and harbours, and the provision of coaling stations, and also to the lighting and charting of coasts that required many years of work and the expenditure of millions of money. Similarly, before regular world-wide air communications can be instituted it will be necessary to provide an equivalent organisation of landing stations with facilities for storage of petrol and the supply of gas, as well as a reliable and elaborately organised meteorological intelligence service.

In general, main bases with sheds and full equipment for the overhaul and refitting of airships will be required only at the terminals of the main routes. The intermediate calling stations need only be provided with mooring masts and arrangements for the supply of petrol, oil and hydrogen. For the operation of the main world routes previously indicated a total of eight main bases would be required, one situated at each of the terminal stations in England, Egypt, India, America, South Africa, South America, Japan and the United States.

The table below, which shows the time saved in travelling by airship to a number of important centres, has been calculated on the assumption that an average speed of 60 miles per hour would be made good and allowing a stop of from four to six hours at the various intermediate calling stations for replenishing with petrol, oil and gas.

TIME SAVING BY AIRSHIP TRAVEL.

| Voyage. | Time by Airship. | Time by Train and Steamship. | Time saved by Airship. |
|---|---|---|---|
| | Days. | Days. | Days. |
| London to Cairo | 2 | 6 | 4 |
| ,, ,, Bombay | 4½ | 14-16 | 9½-11½ |
| ,, ,, Singapore | 6½ | 25 | 18½ |
| ,, ,, Sydney | 11 | 30 | 19 |
| ,, ,, Hong-Kong | 8 | 24 *via* U.S.A. | 16 |
| ,, ,, Cape Town | 6 | 18 | 12 |
| ,, ,, Buenos Aires | 5½ | 22 | 16½ |
| ,, ,, New York | 3 | 6-8 | 3-5 |
| New York to London | 2½ | 6-8 | 3½-5½ |
| ,, ,, San Francisco | 2¼ | 4 | 1¾ |
| ,, ,, Sydney | 8½ | 24 | 15½ |




AIRSHIP R 80.

Constructed by Messrs. Vickers, Ltd., Barrow-in-Furness.

### Requirements of Commercial Airships.

From a consideration of the air routes indicated above, it appears that the distances between calling stations will vary from 1,000 to 3,000 miles, so that an airship able to fly a distance of 3,000 miles at an economic speed with a suitable reserve of fuel, and to carry a reasonable load of passengers and mails under the worst climatic conditions, would be suitable for commercial operation over any of the world routes. To offer an attractive saving of time, the speed made good from station to station should be at least 60 miles per hour, and to enable this average to be maintained the airships used should be capable, when required, of flying continuously at 80 miles per hour.

To conform to these requirements, and enable an economical load to be carried after allowing for a reserve fuel supply and for the weight entailed in fitting passenger accommodation, a rigid airship of about 4,000,000 cubic feet gas capacity will be needed, such a ship having a length of about 800 feet and a maximum diameter of about 100 feet. This size of ship, with engine power for a speed of 80 miles per hour, would enable accommodation to be provided for 100 passengers, and the airship could also carry a considerable load of mails, etc., the proportion varying according to the length of voyage and the climatic conditions.

As airship journeys will last for several days, properly heated and roomy living saloons, built underneath and exterior to the hull of the airship, would provide day quarters of a more comfortable and restful character than can be obtained in railway travel, and sleeping quarters in cabins built inside the airship's structure could be quite as roomy and comfortable as the usual ships' staterooms. The general specification of an airship designed to meet the requirements outlined above is as follows :—

#### General Specification of Proposed Airship.

| | |
|---|---|
| Gross gas capacity . . . . . . . . | 4,000,000 cubic feet |
| Overall length . . . . . . . . . | 800 feet |
| Overall diameter . . . . . . . . | 100 " |
| Total lift : | |
| Under European conditions (68 lbs. per 1,000 cubic feet) . . . . . | 120 tons |
| Under tropical conditions (63 lbs. per 1,000 cubic feet) . . . . . . | 112 tons |
| Full-power speed . . . . . . . . | 80 miles per hour |
| Cruising-power speed . . . . . . . | 60 " " |
| Full engine power . . . . . . . . | 3,000 B.H.P. |
| Cruising engine power . . . . . . | 1,750 " |
| Lift available for fuel and oil, ballast, crew, stores, passengers, and passenger accommodations, mails, etc.: | |
| Under European conditions . . . | 80 tons |
| Under tropical conditions . . . | 72 " |

Allowing for fuel and oil, with a reserve of 30 per cent., such a vessel could carry 25 tons of mails or freight for a 1,000-mile journey under European conditions, or 12 tons under tropical conditions, while the corresponding figures for a 3,000-mile journey would be

10 tons and 2 tons respectively. In all cases 100 passengers would be carried.

As the largest airship yet built—the R38—was only of 2,700,000 cubic feet capacity, considerable advance has still to be made in design and construction before an airship can be produced suitable for regular and economical passenger service on long-distance routes.

## Cost of Operation.

The capital required and costs of operation will, of course, depend largely on the extent of the services operated. For a route with long stages of continuous flight, the paying load that can be carried will be less than for a route with shorter stages and the cost per unit of traffic will consequently be higher. The overhead charges of a widely organised system will also be proportionately less than for a single route.

Fairly close estimates of the actual running costs can be made, but the costs of maintenance, establishment charges, management expenses, and overhead costs generally can only be determined by actual experience on a commercial scale over a period of years; consequently only approximate figures can be put forward. As a representative case, an estimate is made of the costs of operating a through service for passengers and mails between England and Australia, allowing for a voyage each way twice a month.

The probable time required for the voyage between England and Sydney would be between ten and twelve days, so that the round trip could easily be made in a month, with a week intervening for overhaul, refit of engines, etc. The service would therefore require two ships always in commission. Until experience was gained as to the amount of refit and replacements actually necessary, it would be desirable to have four airships in commission, so that each ship would only need to be in service an average of one month out of two.

The estimated cost of building four airships of 4,000,000 cubic feet with passenger accommodation and specially designed in view of the conditions experienced on this route would be £1,600,000. At each of the terminal stations in England and Australia it would be necessary to have a shed capable of housing two airships, a mooring mast equipment, hydrogen supply plant, workshops with facilities for repairs and replacements, a wireless and meteorological station, and petrol storage. The total cost of each of the terminal stations is estimated at £550,000. Each of the intermediate stations at Marseilles, Cairo, Basra, Bombay, Colombo, Singapore, and Perth would require a mooring mast equipment, hydrogen supply plant, petrol storage, wireless station and supply depôt, and the total cost of equipping the seven stations is estimated at £500,000.

Allowing an additional sum of £50,000 for spare parts, stores, etc., the total capital required would therefore be £3,250,000.

In the absence of actual experience of the working life of airships when operated continuously, it is difficult to decide the rate at

which their value should be written off. From information published by the Zeppelin Co. it would appear that they assess the useful life at five years, so that the charge for depreciation on the four airships would be about £300,000 per annum. For the sheds, mooring masts, and ground equipment generally, allowing a twenty years' life, the depreciation charge would be £80,000 per annum.

As regards the cost of repairs and replacements due to the wear and tear of constant service, it is probable that the fabric outer covers would require replacement every year, the gas bags every two years, and the engines every year. No other parts of the ships are subject to constant wear and tear, but allowance is made for small damages and replacements. There is also, of course, the costs of maintenance of the sheds, mooring masts, gas plants, and other aerodrome equipment, the total expenditure under these headings being estimated at £150,000 per annum.

It is not possible to say what rates would have to be paid for insurance against total loss, and whilst the risks of total loss of an airship will be very small, in the early stages of development, before pilots are thoroughly experienced and methods of handling are fully developed, there is always the possibility of a mishap such as occurred to R34. At the same time it should be pointed out that risks are generally connected only with landing, and up to the loss of R38, not a single life had been lost owing to the wreck or accidental damage to an airship in flight. In the early stages therefore insurance rates will be high, but as the airship companies themselves will be able to undertake minor repairs without much additional expense, the airships will require to be covered for total loss only, which may be taken, as a maximum, at 25 per cent. per annum on the total airship value, amounting for the four ships to £400,000 per annum.

The personnel required for the operation of the service would comprise the airship flying crews, the ground parties at the terminal stations and calling stations, and the management and office staffs at the headquarters. The flying crews required for the four airships would include eight officers and 100 ratings at a total pay per annum of £35,000. The number of hands required at the terminal stations, including mechanics, fabric workers, hydrogen plant workers, and other skilled and unskilled workers necessary for the operation of the station and maintenance of the airships, would be about 150 at each station. Their total annual wages are estimated at £75,000. For management, administration and office expenses, a sum estimated at £15,000 may be allowed.

The working costs for the airships, comprising the cost of petrol, oil, and hydrogen consumed, can be estimated with confidence, and are directly proportional to the actual flying distance and time. For the 4,000,000 cubic feet airship considered the working cost will total under £40 per flying hour. On the basis of a regular service of twenty-five voyages each way per year between England and Sydney, the total flying time would be 10,600 hours, or an average of 2,650 hours per ship. The total flying costs therefore come to £424,000 per annum.

The addition of the items above referred to for depreciation, repairs and maintenance, insurance, personnel, and flying costs, gives a total annual expenditure of £1,479,000. To pay a 10 per cent. dividend on the capital of £3,250,000, a further sum of £325,000 would be required, so that the annual revenue necessary would be £1,804,000.

### Rates for Passengers and Mails.

Assuming that a full load is carried every voyage, the total per year would be about 20,000,000 ton-miles, and, taking a probable average actual load at half the full load, the annual total would be 10,000,000 ton-miles. On this basis the charge necessary to pay working costs and 10 per cent. on capital would require to be 3*s.* 6*d.* per ton-mile.

Passengers, together with their accommodation, luggage, and weight of food, etc., are rated at six to the ton for their carriage, and with a suitable allowance for the cost of meals, etc., the charge necessary would be about 8*d.* per mile. On these rates the charges for transport of passengers and mails from England to India would be about £170 for passengers and about 6*d.* per ounce for mails, while from England to Australia the corresponding charges would be £350 for passengers and 1*s.* 1*d.* per ounce for mails.

It will be seen that about 70 per cent. of the total cost is due to interest on capital, depreciation, insurance, and other charges incident on capital. The capital costs of the airships and station equipment given above are based on actual costs of airships built during the war in this country under most uneconomical conditions. The Zeppelin Co., who have built six or more ships of the same design, have been able to build for less than half the cost in this country, and there is no doubt that if four airships of the same design were built for commercial purposes they could be delivered for considerably less than the figures on which the preceding estimates are based.

Taking everything into consideration, it may reasonably be concluded that, once the initial stage has been passed, it should be possible to operate a regular passenger service at rates not greater than twice the present prices for first-class passage by ocean liner, and also to carry mails at a very reasonable figure in view of the great saving in time that will be effected.

### Possibilities of Improvement and Development.

Rigid airship construction in this country was only really begun in 1914 and has suffered many setbacks owing to vacillation in Government policy, with the consequence that progress in design and construction has been much less than would have been the case if there had been steady and uninterrupted development. Airship design in this country therefore has been largely based on German practice, and it is only in the most recent designs of R80, by Messrs. Vickers, and the ill-fated R38, completed for the Air Ministry, that purely British ideas have been put into effect.

Rigid airships built in this country have also cost at least twice, and probably three times, as much as those built by the Zeppelin Co., due mainly to the fact that we have never yet been able to build on a production scale; in fact, not more than two ships of one type have yet been built by any constructor, whereas the Zeppelin Co. have built at the same works twelve and more in succession of the same design, which has enabled them to erect and complete a ship in three months compared with the usual two years taken by British constructors for the building of a new design. Up to the present time the Zeppelin Co. has built, including the earliest experimental types, a total of 115 ships, as compared with 15 built by four different constructors in this country.

As previously stated it will be necessary to develop airships of considerably greater size than those at present in use before they will be of real commercial value for long-distance transport. The largest airship yet built was the R38, of 2,720,000 cubic feet gas capacity, from which the jump to 4,000,000 cubic feet is one that could quite safely be taken. It is definitely known that designs for an airship of this latter size have been completed by the Zeppelin Co., and experimental girders and other parts have been seen by officers of the Aeronautical Commission in Germany. Under the terms of the Peace Treaty the Germans are, at present, prohibited from airship construction, but as soon as the period of this embargo is terminated we may expect to see the world's first international passenger airship rapidly completed.

With increase in size it will be possible to simplify structural design and relatively to cheapen greatly the cost of construction. Moreover, as the materials used will be of a more substantial nature, the costs of maintenance and repair should be less and the working life of the airship materially increased.

In addition to the increase of size that is necessary to enable paying loads to be carried for non-stop flights of 3,000 miles, at a speed of 80 miles an hour, there are other very important problems that require thorough investigation before we can be satisfied that an airship will be able to operate regularly with reliability in all kinds of weather and under the extremes of atmospheric conditions that will be encountered on a route such as from England to Australia.

The commercial airship must be able to depart and arrive at the calling stations in all kinds of weather with safety and regularity with the assistance of a reasonable number of men such as will normally be employed in the running and maintenance of the station. This problem has already been solved, in principle, by the use of the mooring mast or tower, which has already had sufficient experimental and working demonstrations to indicate that a type can be developed that will meet all the requirements of regular commercial services.

The mooring mast for commercial purposes will be provided with powerful hauling-in winches and coupling gear that will enable mooring to be accomplished safely and without difficulty even in winds up to 70 or 80 miles per hour. A passenger lift will be provided inside the mast structure in which passengers will be raised to a compartment at the top of the mast from which they can enter the

airship by means of a covered-in gangway connected to the internal gangway in the ship communicating with the passengers' quarters.

It will also be necessary to develop a type of airship engine that can run continuously for periods of 50 hours or more without any risk of breakdown and without requiring frequent overhauls by highly-skilled labour. On these long-duration flights the weight of fuel and oil used is many times greater than the deadweight of the engines, and, for this reason, engines could be made more robust and reliable if at the same time even a small reduction in fuel consumption could be attained. The use of a cheaper form of fuel than petrol would also effect a great economy in one of the largest items of running cost.

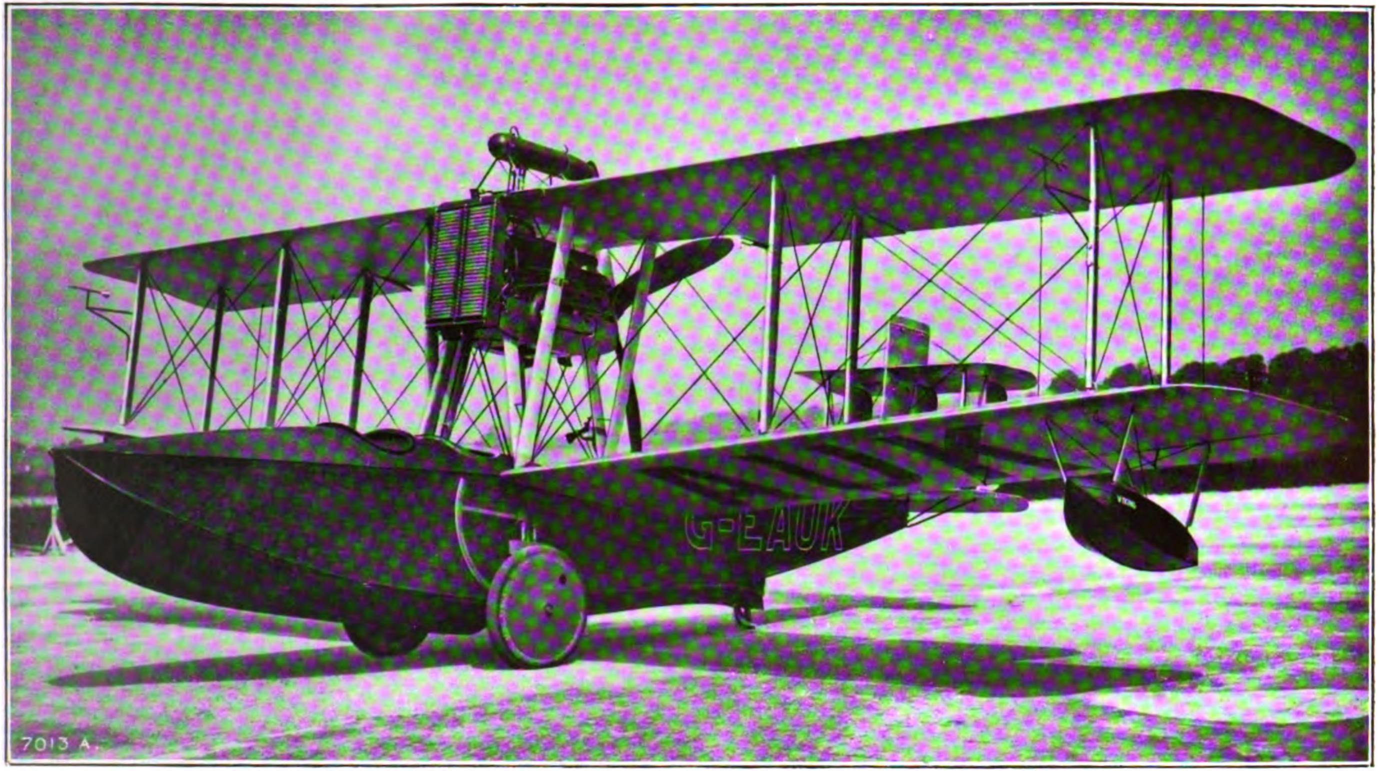
The other large item in running cost is the cost of hydrogen. The consumption of gas is mainly due to the voluntary discharges during flight for the purpose of reducing lift to correspond with the loss of weight due to the consumption of fuel by the engines. The losses of gas escaping by diffusion and leakage are relatively insignificant. By using the hydrogen, that would otherwise be discharged, as fuel in engines specially fitted for this purpose, the value of the petrol saved would practically cover the cost of the hydrogen used. Experiments that have already been carried out on a small scale have demonstrated the practicability of this scheme.

Apparatus can also be developed for condensing the water of combustion in the exhaust gases of the engines, and experiments have proved that it is possible to recover a weight of water almost as great as the weight of fuel consumed, thus making it possible to maintain the ship in weight equilibrium without discharging gas. A combination of these two schemes would effect great economy in the consumption of hydrogen, and also, by reducing the weight of fuel requiring to be carried, allow of a greater paying load being taken with the same size of airship, so directly affecting a great reduction in the charge to be made for carriage.

There is also scope for research in developing a method of treating the outer cover fabric that will ensure tautness and watertightness under extremes of weather and temperature, and so prolong the life and reduce the cost due to frequent replacement, which, at present, is necessary about every twelve months of service.

## Auxiliary Aeroplane Services.

A feature which may well be considered in connection with the development of commercial air services for overseas transport is the inauguration of auxiliary aeroplane services to act as feeders to the airship lines. In its present state of development the aeroplane, and with it, of course, is included the seaplane and amphibian, cannot be regarded as useful for continuous journeys exceeding a few hours in duration. Although aircraft of the heavier-than-air type can cover something like twice the distance in a given time that an airship can, the standard of comfort attainable in the former is not such as could be tolerated for some days, and night flying, in connection with which a number of technical difficulties have still to be overcome, also



VICKERS' AMPHIBIOUS BOAT SEAPLANE.

involves the provision of sleeping accommodation, for which existing machines are unsuitable. An even more reliable engine would also be necessary before long flights overseas could be regularly carried out by aeroplane, and, in any case, the large proportion of the total lift which would have to be sacrificed to carry the necessary fuel for such journeys renders them impracticable at present.

Doubtless the difficulties above referred to will eventually be overcome, but as attention has so far been directed only to such schemes as could be put into immediate operation, aircraft of the heavier-than-air type must be regarded as best fitted for journeys of a few hundreds of miles carried out in daylight. For such work their practicability has been amply demonstrated by the safety and regularity with which the services between this country and the Continent have been carried on since their inauguration. It must be admitted that State subsidies have been found necessary to maintain the British services, but this is largely due to the fact that they had to operate in competition with foreign subsidised services. Moreover, the type of machine employed has not always been that most suitable for commercial work, although several such are already in existence and are used to some extent. There is no need to labour the point, since it is sufficiently obvious, that more economical operating results are possible with machines specially designed for the work they have to perform than with those converted from war service.

It is not, however, proposed to discuss the whole question of the transport of passengers and goods by aeroplane, but briefly to consider the employment of these machines in connection with airship services since, by their use, the maximum time could be saved in a journey between any two points. The function of the aeroplane services would be to collect and distribute passengers, goods, and mails from and to centres of population within a radius of, say, 500 miles from the airships' port of call. The times of arrival and departure of the aeroplanes would be arranged to suit those of the airships, which in all normal circumstances could be worked to a reasonably accurate time schedule, but the former would, of course, carry a considerable amount of traffic in addition to that intended for the airship lines.

The fundamental reason for employing auxiliary aeroplane services is that the provision of a number of intermediate stopping places for airships would be uneconomical, both on account of the cost of the equipment and from the loss of time and waste of gas involved in frequent stoppages; there is no such objection to landing aeroplanes at comparatively short intervals. As previously mentioned a number of machines capable of carrying eight or ten passengers, or the equivalent weight of goods and mails, and also of working reliably and economically in the class of service required, are in existence. Special attention may, however, be called to the advantages of the amphibian for such work. From its ability to start from or alight on either land or sea with equal facility the amphibian is the only aircraft of the heavier-than-air type for which a route can be chosen without considering, in connection with the contingency of a forced landing, the element over which the machine is to fly. It is therefore

possible, if other circumstances render it desirable, to select for the amphibian a straight-line route between any two points separated partly by land and partly by sea, provided that the total distance falls within the economical limits for heavier-than-air craft. In the case of seaport towns, no special landing ground need be provided for an amphibian service since the open sea or a maritime harbour could be used as an aerodrome. The majority of inland towns are also traversed by rivers or situated on the borders of a lake, either of which would form excellent stopping or starting places for amphibians; the former having the obvious advantage that the time occupied in transporting passengers and goods from the centre of the city to a land aerodrome on the outskirts would be avoided.

It may, of course, be several years before the whole scheme outlined above is fully developed, but that something of the kind will eventually materialise is open to but little question. The advantages offered by the airship are too important for them to be entirely neglected, particularly by the nation that has perhaps done more than any other to develop earlier methods of high-speed transport. The first step would appear to be to make a start with that service which offers most advantages over existing methods of transport and which could be inaugurated with comparatively small outlay, viz., that between England, Egypt and India; experience thus gained could afterwards be applied to the extension of this route and to the development of others. The main difficulty is that sufficient traffic might not be forthcoming to render the services immediately profitable, but past experience has shown that if improved transport facilities are provided and maintained, the public is not slow to avail itself of them. Doubtless this experience will be repeated with commercial airship services.

A. TREVOR DAWSON.

## CHAPTER V.

### The Importance of Coastal Shipping.

It is recognised that the material prosperity of the 43 million people living within these islands depends, in great measure, on the selling price at which our exports of manufactures and coal can be placed on the markets of the world. That price must be low enough to induce the producers in other countries to give us in exchange the food without which we cannot exist, and the raw materials without which we cannot manufacture. Our ability to sell at such a price must depend, in the long run, on the cost of producing our exports; and the elements that go to make up that cost are: the price paid for raw material and labour, the cost of maintaining the buildings, plant, and equipment employed, the price paid for skill and enterprise in controlling production and in both buying and selling, the cost of transport, and the cost of the capital employed. We have no longer either individually or as a nation command over almost unlimited capital and credit, for those have been exhausted by the war, and upon all the elements that go to make up cost, other than transport, we have only our efficiency and skill upon which to depend in competition with the manufacturers and producers of other nations. If we are to improve, or indeed even to maintain, our standard of living, our actual cost of production must be comparatively high, and it therefore follows that our aim must be to give in production the maximum possible return for the outlay incurred.

In transport we have advantages over other nations, advantages derived from our geographical position. The opening of the Suez Canal lessened those comparative advantages, but there is still no country better, and few as well, placed as Great Britain in regard to the great trade routes of the world. And amongst these geographical advantages not the least is in the character of our coast line with its many natural harbours. There is no industrial country with as great a coast line in proportion to its size, and in no other industrial country is the sea more readily accessible to a greater proportion of its population.

The facilities we have for sea transport play an all-important part in determining the quantity, variety, quality, and price of the raw material we employ in the production of our exports, and in providing opportunities for the placing those exports on the markets of the world. There is only one sea, and unless we bar by self-imposed tariffs or restrictions the entrances to our ports, our ships can bring in the best and cheapest raw materials, including the food for our workers, that is offering anywhere in the world, and they can

carry our exports to every market in the world which is served by a port.

The employment of sea transport has determined, in great measure, the distribution of our population, and created our great centres of industry. Greater London could never have grown up elsewhere than round a great port through which it was able to draw for its needs from the producers of the world. To secure the advantages of sea transport Glasgow and Manchester have made themselves into great ports. Industries dependent on either overseas supplies of raw material, or on overseas markets for the disposal of their manufactures are being developed on the coast. Away from the sea, the only centres in which there is a concentration of population are those conveniently placed in regard to our inland supplies of coal, and it is open to question whether these centres would ever have come into existence if they had not been established in times when we were dependent on our inland supplies of iron.

### Fourteen Large Ports.

To-day, upwards of 50 per cent. of the total population of Great Britain is grouped round fourteen ports, namely: Bristol, Cardiff, Glasgow, Hull, Leith, Liverpool, London, Manchester, Middlesbrough, Newcastle, Plymouth, Preston, Southampton, and Swansea. The population in the centre of England grouped round Birmingham, Stoke, and Leicester amounts to 8 per cent., and that round Sheffield and Leeds to 7 per cent. Of the remainder, about one-half, or 15 per cent. of the total, is widely distributed over the non-manufacturing districts which, as regards food supplies, are mainly self-supporting, and the balance, or about 20 per cent. of the total, is in the smaller inland towns or centred round the smaller ports.

The process of concentration of population on the coast has been proceeding apace, and of recent years it has become more marked as regards the bigger ports. The cause is to be found in the increase in the size of the vessels employed in overseas trade. In the last twenty-five years, the average size has doubled, whilst the maximum size has increased fivefold. The economic unit is now a vessel carrying about 8,000 tons weight, and the number of ports equipped to deal with such vessels is limited. In the year before the war, upwards of 75 per cent. of our total imports, other than iron ore, and 78 per cent. of our total exports, other than coal, were handled in twelve ports. The iron ore imports and the coal shipments have also been concentrated at a very limited number of ports, but their selection has been determined more by their position in relation to the steel industries or the coal fields than to the size of vessel. The big ship, carrying the big cargo with the maximum of safety and at the minimum of cost, has many advantages; but if such advantages are to be realised to the full, means must be found to turn to the best account the receiving and distributing power of the limited number of ports in which alone the big ship can be accommodated.

### Problem of Traffic Handling.

Speaking generally, those ports are fully equipped both to load and discharge all the cargoes offering, but the capacity of every port to receive and deliver is controlled absolutely by the rate at which the cargoes handled pass through that port. A big port can deal with almost any amount of traffic that is kept moving, but they can be blocked and their activities can be paralysed by even a few weeks' accumulations of either inward or outward cargo. In the maintenance of the flow of traffic, facilities for distribution by sea play a most important part, as they enable the cargoes to be worked not only on to the quays, but also (either direct or through lighters) into the vessels by which the distribution is to be completed. It is this linking up of the carrying power of the big ship with the distributing power of the almost innumerable ports and wharves round our coast that is amongst the most urgent questions of the day.

For many years before the war, the employment of sea transport in this retail distribution from the big ports was not keeping pace with either the growth of traffic passing through those ports, or the needs of the population and industries grouped round the smaller ports. In the five years 1860–64, our foreign commerce was carried by shipping representing 13 million tons net of entrances, whilst in the coasting trade of Great Britain the entrances represented nearly 12 million tons net. In the five years 1910–14, the entrances in foreign trade had increased to 73 million tons net, whilst those in the coasting trade had only increased to 22 million tons. Therefore, whilst in the 50 years the shipping employed in our foreign trade had increased more than fivefold, those in our coasting trade had only doubled.

### Railways *versus* Ships.

In great measure it was the action of the railways which strangled the development of distribution by sea. Their success in competition was based, in part, on the merits of the services they could offer, for they provided greater facilities in the collection and delivery of the traffic, and they relieved the owners of the goods carried from the trouble of insuring against sea perils. In greater part, their success was founded on the fear inspired by their financed strength and by the manner in which they used that strength to paralyse enterprise on the part of the smaller ports. To keep pace with the growth of trade it was not sufficient merely to provide efficient coasting steamships, the smaller ports in their quays and equipment had to be kept up to date. Capital had to be found, and that capital was always at the mercy of any "cut in the rates" the railways chose to adopt to tempt the traffic away from the coasters and the smaller ports. Sea transport could not fight against this form of competition because, as Sir William Acworth has recently pointed out:

"Railway business differs from most other businesses, though not from all, by the fact that the standing charges represent a very high proportion of the total cost of carriage. Roughly speaking, taking the world over, we may say that out of every

sovereign charged to the public, one-third only represents actual cost of operation; another one-third is absorbed in general establishment charges and maintenance of the plant; the remaining one-third goes to remuneration of capital. We may go a stage further, and say that of the third which represents actual cost of operation, only a fraction is chargeable against any individual consignment. Now the result of this is twofold; the one aspect is represented in the railway maxim, 'any rate is better than no rate,' which means to say that the extra cost of what the French economists call the extra ton is almost negligible; and therefore, even a minimum rate yields some margin of direct profit, and accordingly the railway is better off with the traffic than without it. The other aspect is that, as the minimum rate on the extra ton may do little more than cover the extra cost of carrying it, somehow the deficiency must be made up; some traffic must not only pay its share of total cost—operation, maintenance, and capital charges—but must make up the share of these charges which the traffic charged at the lowest rates fails to pay, either because at higher rates it would not be profitable to send it, or because it has access to a cheaper form of transport."

## Difficulties of the Small Ports.

During the war the difficulties of the smaller ports were gravely accentuated. The policy adopted by the State of keeping the railway rates to their pre-war level, in spite of greatly increased cost of working, conferred a subsidy on all traffic sent by rail; and this State aid coupled with the "cuts" in the rates "based on the almost negligible cost of carrying the extra ton," which were already in existence for all port-to-port traffic that could be carried by either sea or rail, placed the smaller ports, and the coasting vessels by which they were served, in a hopeless position. This vicious system of employing money derived from taxation to encourage traders to transfer to the railways traffic which on economic grounds should have been sent by sea, resulted in the railways being overwhelmed with traffic. In consequence the bigger ports became congested whilst the smaller ports were left idle. Stocks of food and raw materials were allowed to accumulate and deteriorate in the bigger ports. The big ships were kept waiting for weeks for berths at which to discharge their cargoes, and thereby their yearly carrying power was most seriously diminished. The supplies for which the nation stood in urgent need were here within the country, but there was shortage everywhere, and with it came the inevitable rise in prices. These deplorable results followed inevitably from neglect to turn to account our geographical advantages in sea transport, and that neglect was due to mere ignorance, not to intention. When the war was over, it took weeks of work to make the Ministry of Food realise that the greater part of the country could be fed from the big ports through the smaller ports, even whilst the whole of the railways were idle.

The absurd State bounty on traffic sent by rail was withdrawn when the railway rates were increased, but the system adopted was based on a flat per-centage increase on the existing rates. The result has been that the "cut port-to-port rate" has been doubled along with all the other rates, and, therefore, the traffic that should on economic grounds be passed through the smaller ports is being diverted to the railway at the expense of other classes of traffic which have not access to sea transport.

## Development of Road Transport.

Although the mistaken war policy of the State has imposed a severe handicap on the smaller ports, the war has forced to the front the uses to which road transport can be put, and thereby demonstrated a means by which sea transport should be able to regain the position to which it is entitled. The competition of the railways, in so far as it was based on the better services they could give in door-to-door carriage, was sound and healthy, and it can only be met by the coasting vessels and the smaller ports giving services of equal value. The development of road transport should make this possible. No doubt the range within which the roads can compete successfully with the railways is limited, but apparently for a distance of 15 miles road transport has many advantages to offer. If for the long haul from port to port, the smaller ports have the services of efficient coasting vessels, and if for collection and delivery within 15 miles of the ship's side they have the services of efficient road transport, they should be able to compete successfully with the railways. It may be that they will not be able to quote rates below "the almost negligible cost of carrying the extra ton" of rough cargo over the railways, but the railway "cut rates" are only possible so long as they have other traffic upon which they can impose the share of their general charges which they intentionally forego in cutting the rate. It should be the aim of the smaller ports to capture this other traffic, and that can only be done by providing services from door to door equal to those offered by the railways.

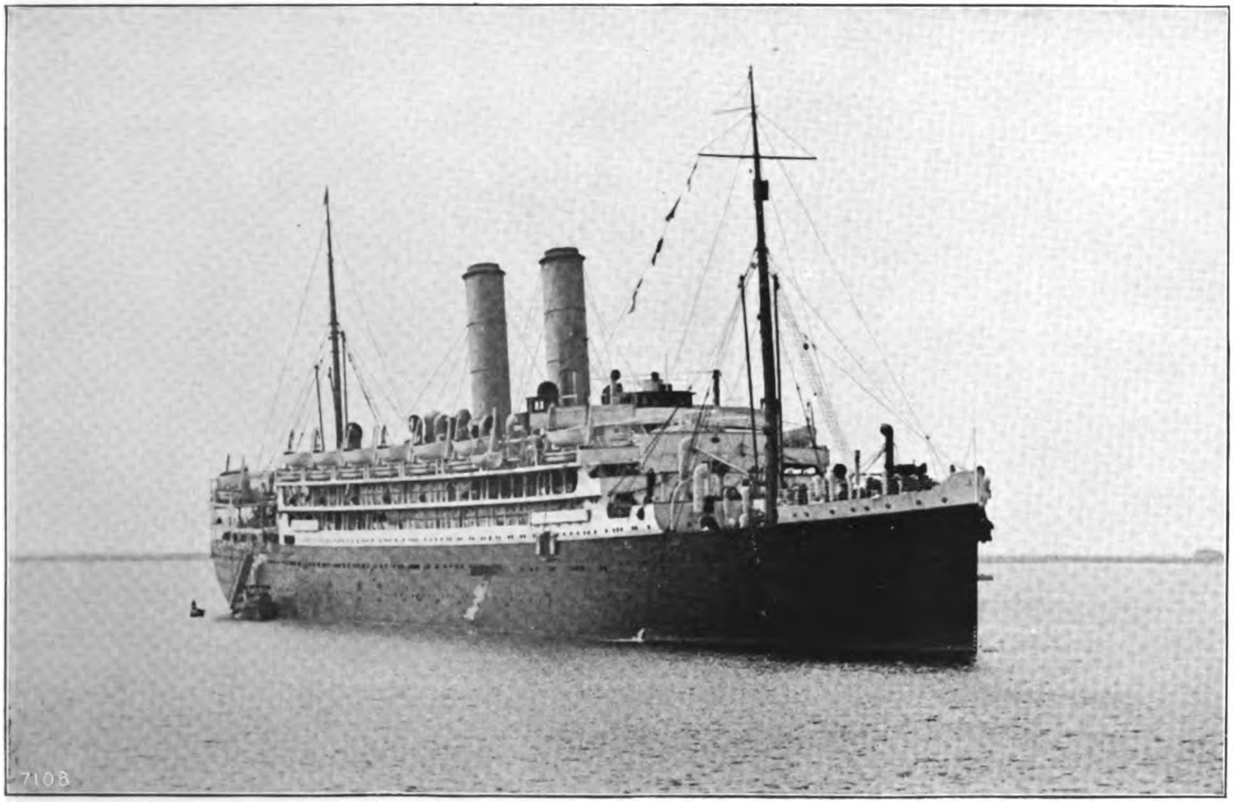
## The Future of the Smaller Ports.

There will be no difficulty in securing efficient coasting vessels. The real problem is the re-establishment of confidence in the smaller ports. Most of them are maintained as public undertakings for the benefit of the areas they serve, and not with a view to making profits. Their charges are regulated by statute, and the capital upon which they have to earn a return is represented by money borrowed in the district at a low rate of interest. In other cases the port undertaking is maintained by the ratepayers. For years they have been at the mercy of the railway "cuts," and the reckless and thoughtless policy of the State during the war has reacted upon them disastrously. But the position must be remedied to enable the nation as a whole to reap the full advantages of sea transport. The smaller ports in their receiving and loading appliances must be brought up to date. The bigger ports must provide greatly improved facilities for the handling of coastwise traffic. To attain these ends confidence must be re-established in both the smaller and the bigger ports: they must be satisfied that the facilities they provide will be used, and they must have reasonable assurance that the railways will not employ the resources they derive from the whole of the traffic they carry in capturing the trade and strangling the development of the smaller ports. Some safeguards have been provided in the recent Railway Act, but, in the main, the security of the smaller ports must

lie in the development of road collection and distribution, within their immediate areas. With such an organisation they should be able to beat the railways at their own game, and indeed to carry the war into the railway camp by capturing the traffic from which the railways have been extracting the resources they have used to destroy the free use of sea transport.

The railway maxim that "any rate is better than no rate" may have for a time to be adopted by the smaller ports, but in the end the railways will be unable to maintain such rates on traffic generally as will provide them with funds to paralyse and strangle the employment of the extraordinary advantages that the harbours around our coast place at the disposal of the nation as a whole.

NORMAN HILL.




(*Photo: Allen & Gill, Plymouth.*)

ORIENT MAIL STEAMER ORMONDE.

**Constructed by Messrs. John Brown & Co., Ltd., Clydebank, N.B.**

## CHAPTER VI.

### The Cost of Speed.

If we examine the history of the fleet of any of the great lines of merchant vessels which form the main arteries of the world's system of communications, we invariably find that the story is one of continual and steady increase in dimensions and in speed. Each successive vessel added to the service is larger and faster than her immediate predecessor; she has more accommodation and carries a greater deadweight. This process of enlargement is a natural result of the growth in the volume of traffic fostered by the successful running of the existing vessels. The larger the vessel, the more economically can passengers and goods be carried, provided always that there is a sufficient volume of both to utilise fully the new facilities.

The following list of ships built for the Orient Line may be taken as illustrative of the expansion referred to :—

| Year. | Vessel. | Length (Feet). | Tonnage. | Trial speed (Knots). |
|---|---|---|---|---|
| 1879 . . . | Orient | 445 | 5,390 | 15·54 |
| 1881 . . . | Austral | 455 | 5,590 | 17·03 |
| 1886 . . . | Ormuz | 465 | 6,120 | 17·45 |
| 1891 . . . | Ophir | 465 | 6,940 | 18·75 |
| 1898 . . . | Omrah | 490 | 8,290 | 17·04 |
| 1902 . . . | Orontes | 512 | 9,020 | 17·83 |
| 1908 . . . | Otway<br>Orsova<br>Osterley<br>Orvieto<br>Otranto | 535 | 12,120 | 18·45 |
| 1911 . . . | Orama | 550 | 12,930 | 18·34 |
| 1917 . . . | Ormonde | 580 | 14,850 | 18·50 |

It will be seen that the growth in size is more regular than the increase of speed. This is explained by the fact that the terms upon which the mail subsidy is granted specify a maximum number of days which must not be exceeded on the voyage, and as long as the vessel can land her mails within the stated time nothing is to be gained by increase of speed. It is, of course, natural that passengers should desire to travel as quickly as possible and that the Dominion governments should be eager to have more rapid transport of mails, commodities, and persons, but as we shall see presently in detail, speed at sea is an expensive matter for which the shipowner is averse from paying unless he can foresee an adequate return for his enterprise in the form of increased freight, or passage money, or a handsome supplement

to the mail subsidy. In the absence of the latter incentive, his only inducement to build a more expensive vessel or to enlarge dimensions is to secure an increased earning power by providing accommodation for a greater number of passengers and by carrying more cargo. There is also to be satisfied the chronic demand for more and more attractive accommodation, more space and greater luxury both for passengers and crew. In the earlier steamers, dining saloon, music-room and smoke-room sufficed, with natural ventilation, steam heating and candle lamps. To-day we find the lounge, the palm court, the verandah café, card room, children's room, sun parlour, gymnasium, swimming bath, Turkish bath, library, writing-room, and so on. Elaborate systems of power ventilation and heating are introduced, electric light everywhere, and running water to every cabin. The number of passengers per room is also reduced, the first-class accommodation now including many one-berth and two-berth cabins. All these items involve weight and cost, more deck space and a larger ship. We thus find an explanation of the tendency of ships to grow, irrespective of any question of speed. And the larger the vessel for any given speed, the easier relatively does it become to maintain the required rate of progress.

## The Influence of Subsidies.

Let us suppose, now, that an increased subsidy is offered on condition that the number of days on the voyage is reduced. We are at once faced with the problem of obtaining increased speed and of ascertaining what such increase will involve both in the cost and in the qualities of the new vessel.

In determining the amount by which the speed is to be augmented, consideration must be given to the effect of the acceleration upon the times of arrival and departure, and much will depend upon whether any latitude can be permitted in the time table. On a cross-Channel run of a few hours' duration, every minute saved will allow of an earlier arrival at the passengers' ultimate destination, and on the transatlantic passage the shore times can be adjusted to suit almost any speed. But on a longer voyage, with many intermediate ports of call, it may be necessary to adhere to certain hours of arrival and departure and to aim at reducing the passage by whole day units. The distance over which the mails have to be carried between the port of shipment in Italy and Fremantle, the first port touched at in Australia, for example, is 7,460 miles, excluding the length of the Suez Canal, and if a uniform speed could be maintained over the whole of this distance, irrespective of the hours of arrival and departure at intermediate ports, an increase of speed from 16 to 17·85 knots would reduce the passage by 48 hours, 6 hours being saved before reaching Port Said, 22 hours between Suez and Colombo, and 20 hours during the last stretch to Fremantle. If, however, the hours of arrival and departure were unalterable, the speed would have to be increased to 18·25 knots in order to save one whole day on each of the long runs: a difference in speed of nearly half a knot for the same total saving of two days in the mail delivery.

### The Cost of an Extra Knot.

To determine the cost of an extra knot or two, let us take, as a basis, some existing vessel which carries known weights of cargo, passengers, stores, and water, and sufficient coal—plus a margin of say 20 per cent.—to enable her to travel between two given ports at a definite speed. The simplest case is that in which the ports are terminals and coaling stations, so that fuel need not be carried either way for the return journey. Let it be desired to build a new vessel for the same service but of greater speed. Three alternatives may be considered.

I. We can adopt exactly the same dimensions and form as those of the basis vessel and simply install more powerful machinery. There will naturally be a greater weight of machinery, and in spite of the reduction of time on the voyage, a greater consumption of fuel. Both of these charges upon the carrying capacity must be compensated for by foregoing cargo, and against this the only saving will be a small item of fresh water and provisions saved owing to the lesser time that the passengers will be on board. This method, though perhaps the most obvious one, is not likely to be satisfactory, as the vessel would probably be of a fulness of form not suited to the higher speed and would be uneconomically over-driven. There would be greater initial cost, increased running expenses, and less earning power.

II. We can adhere to the dimensions of the basis vessel, but reduce her block-coefficient so as to make her of a finer and more easily driven form. The increase in power will not now be so great, but cargo will have to be sacrificed in order to compensate both for the added weights of machinery and fuel and for the reduction in displacement. The weight and cost of the hull will be slightly less on account of the finer form, but the weight and cost of both machinery and fuel will be increased, and the earning capacity diminished. So that again the new venture will not pay so well as the basis proposition unless a higher subsidy or increased fares and freights can be obtained.

III. We can increase the dimensions and construct a larger vessel of finer form than her prototype. More power will probably be required, but more passenger accommodation can be provided, while the cargo deadweight can be maintained or even increased. This vessel will be economically driven and will have a better earning capacity even apart from any enhanced subsidy she may receive.

### The Advance from 18 to 21 Knots.

As a concrete example let us consider as our basis vessel a shelter-decked passenger and cargo steamer 560 feet long, 66 feet beam, and 56 feet in depth to her bridge deck, capable of carrying 3,740 tons of cargo, and 20 per cent. more than sufficient coal for a voyage of 3,050 miles at a mean speed of 18 knots, propelled by quadruple-expansion reciprocating engines and twin screws. In this vessel let us install machinery of greater power so as to obtain in succession

mean speeds of 19, 20, and 21 knots. Table I. below shows the penalties exacted by each additional knot.

TABLE I.—TWIN SCREW STEAMER 560′ × 66′ × 56′.

Load Displacement 19,250 Tons on 27′ 0″ Draft. Block Coefficient 0·684.
Coal per I.H.P. per hour 1·43 lb. Voyage 3,050 miles.

| Mean speed on service, knots. | 18 | 19 | 20 | 21 |
|---|---|---|---|---|
| I.H.P. on service | 16,600 | 20,700 | 26,150 | 33,000 |
| Weights in tons— | | | | |
| Hull | 9,100 | 9,100 | 9,100 | 9,100 |
| Machinery | 3,150 | 3,680 | 4,350 | 5,250 |
| Coal consumed | 1,800 | 2,130 | 2,530 | 3,100 |
| Coal margin 20 % | 360 | 425 | 505 | 620 |
| Reserve feed water | 200 | 235 | 280 | 340 |
| Fixed stores | 500 | 500 | 500 | 500 |
| Consumable stores | 400 | 380 | 360 | 340 |
| Cargo | 3,740 | 2,800 | 1,625 | 0 |
| Load displacement | 19,250 | 19,250 | 19,250 | 19,250 |
| Quarter of consumables | 600 | 690 | 790 | 950 |
| Mean service displacement | 18,650 | 18,560 | 18,460 | 18,300 |
| „ „ block coefficient | 0·682 | 0·681 | 0·680 | 0·679 |

In the above it is assumed that during the voyage water ballast equal in weight to one-half of the weights consumed is added in order to maintain stability and trim, so that the mean displacement, or the displacement at mid-voyage, is equal to the starting weight less one quarter of the weight of the fuel, stores, and fresh water consumed during the voyage. It will be seen that as the speed is increased the horse-power and fuel consumption rise more and more rapidly, with serious effect upon first cost and running expenses, while the cargo deadweight as rapidly diminishes and takes with it one of the important items upon the credit side of the balance sheet. A 21-knot vessel under the given conditions would carry no cargo, would probably be so full of machinery, boilers, and coal as to have little space for cargo anyhow, and would have a coal bill 72 per cent. in excess of her 18-knot prototype. The Campania and Lusitania were practically in this category, the whole of the available weight and space, after allowing for hull and passenger requirements, being devoted to the machinery and fuel necessary to maintain their racing speeds.

### EFFECT OF HIGHER SPEED ON SHIP'S COEFFICIENT.

In the present instance, the block coefficient of 0·679 is uneconomically great for a sea speed of 21 knots on a length of 560 ft. The speed of a vessel is properly considered in relation to her length of waterline, or rather in relation to the square root of that length, so that the value of what is called the "speed-length ratio" or $V \div \sqrt{L}$ is a good index or criterion as to whether a vessel should be regarded as slow or speedy. For tramps this ratio has a value of

about 0·55, for liners about 0·75, for cross-Channel steamers about 1·2, and for destroyers about 2·2. For the Campania it was 0·82, for the Lusitania 0·91. As a general rule increase in speed-length ratio should be accompanied by fining of the lines and a good working connection between these two factors of speed and fineness is given by the rule which makes the block coefficient equal to 1·06 minus one-half of the speed-length ratio.

For a 560 foot 21-knotter, the speed factor is 0·888, so that a suitable value for the block coefficient would be 1·06 − 0·444 = 0·616. Let us consider, therefore, the result of endeavouring to improve the qualities of our basis vessel by the process of gradually reducing the block coefficient as we increase the speed, until we reach, say, 0·62 coefficient at 21 knots. Table II. below shows the details of this scheme.

TABLE II.—TWIN SCREW STEAMER 560′ × 66′ × 56′.

Load Draft 27′ 0″. Block Coefficient and Displacement reduced as Speed is increased. Voyage 3,050 miles.

| Mean speed on service, knots . | 18 | 19 | 20 | 21 |
|---|---|---|---|---|
| I.H.P. on service . . . . | 16,600 | 19,350 | 22,500 | 25,750 |
| Weights in tons— | | | | |
| Hull . . . . . . . . | 9,100 | 9,050 | 9,000 | 8,950 |
| Machinery . . . . | 3,150 | 3,500 | 3,900 | 4,300 |
| Coal consumed . . . . | 1,800 | 2,000 | 2,200 | 2,400 |
| Coal margin 20 % . . . | 360 | 400 | 440 | 480 |
| Reserve feed water . . . | 200 | 220 | 240 | 260 |
| Fixed stores . . . . . . | 500 | 500 | 500 | 500 |
| Consumable stores . . . | 400 | 380 | 360 | 340 |
| Cargo . . . . . . . . | 3,740 | 2,650 | 1,480 | 320 |
| Load displacement . . . . | 19,250 | 18,680 | 18,120 | 17,550 |
| Quarter of consumables . . | 600 | 650 | 700 | 750 |
| Mean service displacement . | 18,600 | 18,030 | 17,420 | 16,800 |
| Block Coefficient . . . . | 0·68 | 0·66 | 0·64 | 0·62 |

### THE EFFECT OF HIGHER SPEED ON SHIP'S DIMENSIONS.

This is much better. We still have to pay a penalty in power, consumption and loss of cargo for each advance in speed, but to a lesser degree, and 21 knots is attained with only 33 per cent. increase in the coal bill and a small amount of cargo to help the credit side. Nevertheless we have not improved the vessel as a commercial proposition, unless, on account of her greater speed, increased rates of freight, passage money, or mail subsidy are obtainable.

Let us, therefore, endeavour so to enlarge the dimensions that the desired addition to speed can be obtained without loss of carrying power.

Incidentally the enhanced deck areas will afford space for more passenger accommodation, so that the revenue from this source will be increased. Suitable dimensions and other particulars are indicated by Table III. on page 272.

TABLE III.—TWIN SCREW STEAMERS TO CARRY 3,740 TONS CARGO ON 27′ 0″ LOAD DRAFT.

Length and Breadth increased and Block Coefficient reduced as speed is increased. Voyage 3,050 miles.

| | | | | |
|---|---|---|---|---|
| Mean speed on service, knots . | 18 | 19 | 20 | 21 |
| Length, feet . . . . . | 560 | 605 | 650 | 659 |
| Breadth, feet . . . . . | 66 | 70·5 | 75 | 79·5 |
| Depth, feet . . . . . . | 56 | 56 | 56 | 56 |
| I.H.P. on service . . . . | 16,600 | 21,250 | 26,750 | 33,000 |
| Weights in tons— | | | | |
| Hull . . . . . . . . | 9,100 | 10,600 | 12,130 | 13,690 |
| Machinery . . . . | 3,150 | 3,740 | 4,480 | 5,250 |
| Coal consumed . . . . | 1,800 | 2,200 | 2,640 | 3,100 |
| Coal margin 20 % . . . | 360 | 440 | 630 | 620 |
| Reserve feed water . . . | 200 | 240 | 290 | 340 |
| Fixed stores . . . . . | 500 | 580 | 660 | 740 |
| Consumable stores . . . | 400 | 440 | 480 | 520 |
| Cargo . . . . . . . | 3,740 | 3,740 | 3,740 | 3,740 |
| Load displacement . . . . | 19,250 | 22,000 | 24,950 | 28,000 |
| Quarter of consumables . . | 600 | 720 | 855 | 990 |
| Mean displacement on service | 18,650 | 21,280 | 24,095 | 27,010 |
| Block coefficient. . . . . | 0·68 | 0·674 | 0·668 | 0·662 |
| $V \div \sqrt{L} \div 2$ . . . . . | 0·38 | 0·386 | 0·392 | 0·398 |
| | 1·06 | 1·06 | 1·06 | 1·06 |

In this table it is assumed that the load draft is limited to 27 ft., and as the ratio of length to depth even for the longest vessel is only 12·4, the vessels would be amply strong, and it is therefore not necessary to increase the depth.

The table indicates what would probably occur in practice if increased speed were desired. There would be no loss in earning power on account of cargo, while there would be an increased revenue from passengers to set off against the larger coal bill. The item "Fixed stores" is the weight of passengers, crew, baggage etc., and is roughly proportional to the number of passengers carried. It will be seen that the 21-knot vessel carries about 50 per cent. more passengers than her 18-knot predecessor.

## THE INFLUENCES OF DOUBLE-GEARED TURBINES AND OIL FUEL.

So far we have retained the reciprocating engine and coal fuel, and have not considered the possibility of improvement due to any advance which might lie within the province of the marine engineer. But many such advances have been made within recent years and have a very profound effect upon the problem of obtaining increased speeds. Double-reduction geared turbine machinery is considerably lighter than the reciprocating engines which it has so largely displaced, and it occupies less space. Three tons of oil fuel can produce the same quantity of steam as four tons of coal, and with very much less difficulty in bunkering, stowing, and stoking. If we were to install these two latest weapons of the marine engineer in the

vessels, shown in Table III. on page 272, we should obtain the results given in Table IV.

TABLE IV.—TWIN SCREW STEAMERS: 27′ 0″ LOAD DRAFT.

With Double-Geared Turbines and Oil Fuel. Voyage 3,050 miles. Oil per S.H.P. per hour, 1·1 lb.

| | | | | |
|---|---|---|---|---|
| Mean service speed, knots | 18 | 19 | 20 | 21 |
| Length, feet | 560 | 605 | 650 | 695 |
| Breadth, feet | 66 | 70·5 | 75 | 79·5 |
| Depth, feet | 56 | 56 | 56 | 56 |
| S.H.P. on service | 16,600 | 21,250 | 26,750 | 33,000 |
| Weights in tons— | | | | |
| Hull | 9,100 | 10,600 | 12,130 | 13,690 |
| Machinery | 2,850 | 3,400 | 4,850 | 4,800 |
| Fuel consumed | 1,395 | 1,715 | 2,050 | 2,400 |
| Fuel margin 20 % | 280 | 345 | 410 | 480 |
| Reserve feed water | 200 | 240 | 290 | 340 |
| Fixed stores | 500 | 580 | 660 | 740 |
| Consumable stores | 400 | 440 | 480 | 520 |
| Cargo | 4,525 | 4,680 | 4,880 | 5,130 |
| Load displacement | 19,250 | 22,000 | 24,950 | 28,100 |
| Quarter of consumables | 500 | 600 | 705 | 815 |
| Mean displacement on service | 18,750 | 21,400 | 24,245 | 27,285 |
| Block coefficient | 0·681 | 0·675 | 0·669 | 0·663 |

Turbines and oil fuel have completely altered the whole aspect of the problem. We now have not only obtained additional passenger accommodation but a very handsome increase in the cargo deadweight. So great is this addition to cargo weight that some difficulty may be experienced in finding sufficient space in which to stow it, although the greater compactness of the turbine machinery, the reduction in the number of boilers required, and the fact that the oil fuel may be stowed in the double bottom, help largely to increase the capacity for cargo. It is even possible that the freight department might be unable to obtain sufficient weight of cargo to utilise the capacity of the vessel to its full extent, in which case it might pay to make the vessels of somewhat finer form, carrying less cargo, but effecting a further saving in fuel. If cargo were forthcoming in sufficient quantity, room might be made for it by removing passenger accommodation from the 'tween decks and arranging it in additional superstructures. This would of course increase the weight of hull and probably render an increase of beam imperative to maintain a satisfactory amount of stability.

Having the advantages offered by the geared turbine and oil fuel, is it necessary to increase the dimensions at all if we are content with the same passenger and cargo capabilities? How much additional speed can we obtain in our basis vessel by installing modern propelling plant of greater power but of no greater weight than that previously allotted to reciprocating engines and coal? We have in the basis vessel for 16,600 I.H.P., and 18 knots speed, weights apportioned as follows:

| | |
|---|---|
| Machinery . . . . . . . | 3,150 tons. |
| Coal and margin . . . . | 2,160 „ |
| Reserve feed water . . . . | 200 „ |
| Consumable stores . . . | 400 „ |
| | 5,910 „ |

On the same total weight we can install double-geared turbines of 20,700 S.H.P. giving a sea speed of 19 knots, the details being—

| | |
|---|---|
| Machinery . . . . . . . | 3,340 tons. |
| Oil and margin . . . . . . | 1,955 „ |
| Reserve feed water . . . | 235 „ |
| Consumable stores . . . . | 380 „ |
| | 5,910 „ |

A gain of 1 knot has thus been obtained by the introduction of the latest word in marine engineering, and the only penalty is to be found in the greater cost of oil per ton as compared with coal. Against the latter disadvantage there may be set the smaller number of stokers required, the decreased cost of taking in fuel, the gain in cargo space, the greater cleanliness, and the quicker turn round of the vessel in port. That these desiderata outweigh the extra fuel cost may be regarded as sufficiently proved by the general adoption of oil fuel for all liners now being constructed and by the many recent expensive "conversions" of coal burners for the use of liquid fuel. The basis vessel could also be driven at a mean speed of 21 knots, carrying 1240 tons of cargo and consuming 2400 tons of oil, as compared with no cargo and a consumption of 3100 tons of coal. Or by fining the lines a speed of 18·75 knots could be realised with the original 3740 tons of cargo on 1500 tons oil, or to 21 knots with 1330 tons of cargo and a consumption of 1850 tons of fuel.

### The Case of the Australian Liner.

So far we have been considering a comparatively short ocean voyage, approximately equal to the Transatlantic trip from Liverpool to New York or Montreal, or to the long stretches of the Australian itinerary. We have seen that, even for such distances, speed invariably demands as penalties extra fuel and diminished cargo or increased dimensions. On the Atlantic route, the volume of passenger traffic has always been so great and the demand for speed so insistent, that the enhanced fares obtainable on the faster vessels, together with the greater number of passengers that can be carried per ship as the dimensions are increased, are sufficient justification for the outlay on speed. But on the longer routes connecting the mother country to out-lying parts of the Empire, conditions are less encouraging. On the longer ocean runs, economy of fuel is of more vital importance in the balance sheet, while the passenger traffic is neither so constant nor so voluminous. If in the case of any of the vessels whose

particulars are given in the preceding tables we have to traverse double the distance between fuelling ports, the amount of fuel which must be carried will also be doubled and the cargo must be correspondingly reduced. Six thousand two hundred miles is about the distance from Vancouver to Yokohama, via Honolulu, on the western route to the Far East, or from Plymouth to Cape Town on the South African service. On a long run, since the consumption of fuel, water, and stores is greater, the average displacement will be less

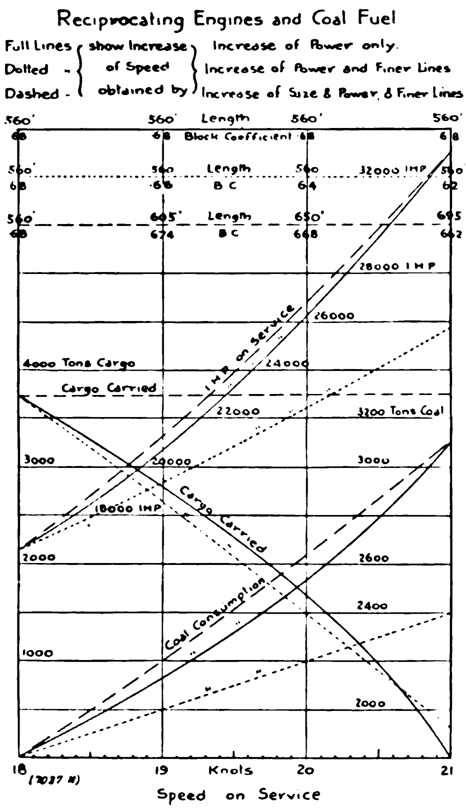



FIG. A.—ILLUSTRATING TABLES I., II., and III.

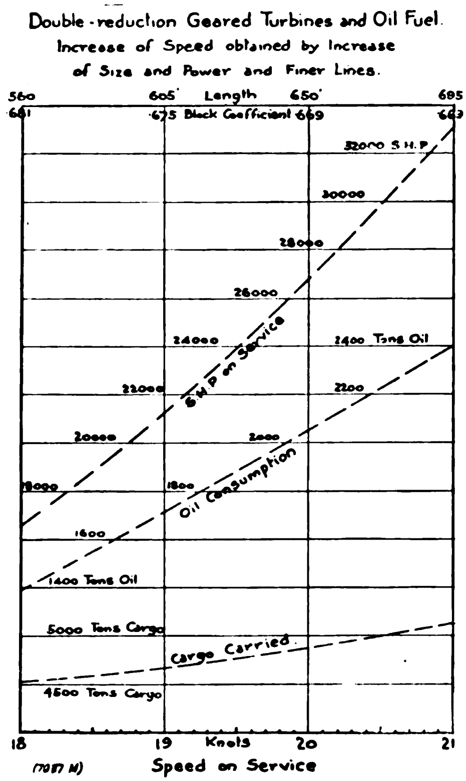



FIG. B.—ILLUSTRATING TABLE IV.

than for a short trip, with a corresponding easement in power. The vessels of Table IV., if put upon a 6,200-mile voyage, would have their displacements made up as in Table V. on page 276.

## THE LOSS IN CARGO CAPACITY DUE TO SPEED.

We have lost about 40 per cent. of our cargo in the 18-knot, and 70 per cent. in the 21-knot vessel. To revert to our basis weight of 3740 tons, it will again be necessary to apply the size cure.

TABLE V.—TWIN SCREW STEAMERS.

Double-Geared Turbines and Oil Fuel. 27′ 0″ Load Draft. Voyage, 6,200 miles.

| Mean speed service, knots | 18 | 19 | 20 | 21 |
|---|---|---|---|---|
| Mean service S.H.P. | 16,250 | 20,700 | 26,000 | 32,400 |
| Length | 560′ | 605′ | 650′ | 695′ |
| Breadth | 66′ | 70·5′ | 75′ | 79·5′ |
| Depth | 56′ | 56′ | 56′ | 56′ |
| Weights in tons— | | | | |
| Hull | 9,100 | 10,600 | 12,130 | 13,690 |
| Machinery | 2,820 | 3,350 | 3,980 | 4,710 |
| Oil consumption | 2,750 | 3,350 | 4,000 | 4,700 |
| Oil margin 20 % | 550 | 670 | 800 | 940 |
| Reserve feed water | 240 | 290 | 350 | 420 |
| Fixed stores | 500 | 580 | 660 | 740 |
| Consumable stores | 600 | 660 | 720 | 780 |
| Cargo | 2,620 | 2,500 | 2,310 | 2,120 |
| Load displacement | 19,250 | 22,000 | 24,950 | 28,100 |
| Quarter of consumables | 900 | 1,075 | 1,270 | 1,475 |
| Mean service displacement | 18,350 | 20,925 | 23,680 | 26,625 |

Considering only the two extreme speeds, we shall obtain the results given in Table VI.

TABLE VI.—TWIN SCREW STEAMERS.

Double-Geared Turbines and Oil Fuel. Voyage, 6,200 miles.

| Mean speed on service, knots | 18 | 21 |
|---|---|---|
| Mean S.H.P. on service | 17,500 | 37,000 |
| Length | 605′ | 740′ |
| Breadth | 70′ 6″ | 84′ |
| Depth | 56′ | 56′ |
| Load draft | 27′ 0″ | 27′ 10″ |
| Weight in tons— | | |
| Hull | 10,650 | 15,500 |
| Machinery | 3,000 | 5,250 |
| Oil consumption | 2,960 | 5,350 |
| Oil margin 20 % | 590 | 1,070 |
| Reserve feed water | 260 | 480 |
| Fixed stores | 580 | 840 |
| Consumable stores | 700 | 890 |
| Cargo | 3,740 | 3,740 |
| Load displacement | 22,480 | 33,120 |
| Quarter of consumables | 980 | 1,680 |
| Mean service displacement | 21,500 | 31,440 |
| Mean service block coefficient | 0·689 | 0·675 |

## HOW SPEED IS EXPENSIVE.

Perhaps enough has now been said to show in what way speed is expensive. In the examples given we have adhered to one type of vessel and to a constant load draft (except in the 21-knotter

of Table VI.). But since each particular service has its own peculiar conditions as to passenger and cargo requirements, as to dimensions and draft, as to distances, subsidies, qualities of fuel obtainable, as to average weather conditions, the nature of the accommodation desirable, the relative proportions of first-, second-, and third-class passengers, and so on, it follows that no standard solution is applicable to all services, and that development proceeds along the differing lines most suited to the several trades. Yet the broad principles we have been considering are operative in each type, and if an accelerated scheme of transport is desired, its cost will always have to be met. The marine engineer and the naval architect have done much to minimise the penalties on speed; the engineer by the development of more efficient and more economical means of propulsion and by the reduction of machinery weight per unit of power developed; the naval architect by effecting economies in the structural weights and the evolving of less resistful forms by means of tank experiments. Against these we have the demands of the travelling public and the vessel's complement for more space, more luxury, lower fares and higher wages, which to the shipowner mean greater initial cost and reduced earnings.

## Future Prospects.

In the future, as in the past, we have no doubt that history will repeat itself, and that ships will continue to grow in dimensions, machinery will be devised of less weight, more power, and less greed for fuel. The water-tube boiler has not made much headway in the mercantile marine, except in the case of high-speed cross-Channel steamers, though wonderful results have been realised in naval vessels by its means, the horse-power developed per ton of machinery rising to as much as 70 or 80. It is more than probable that the internal-combustion engine will be developed so as to be applicable to large and fast ocean liners, its low fuel consumption, of less than half a pound of oil per brake-horse-power, offering the strongest possible incentive. Such a motor as the Doxford opposed-piston engine, for example, in which two colinders are combined so as to occupy no more floor space than one and which can operate upon ordinary fuel-oil, is a very attractive proposition, especially for long-distance steaming, and by the adoption of four lines of shafting, a very considerable total horse-power is already possible. For oil tankers and slow cargo boats, the internal-combustion engine is now the most satisfactory means of propulsion, and its entry into the domain of fast liner propulsion is probably only a matter of time.

## Three Cunarders Compared.

As a further concrete example of the cost of speed, it is of interest to compare the qualities of three notable Cunard Liners—the Campania, Lusitania, and the new Scythia. The Campania and Scythia are of the same length, 600 feet. The former crossed the Atlantic at an average speed of 20 knots; the latter is to jog along at a comfortable 16 miles

per hour. The Campania developed about 26,000 I.H.P. on service and consumed about 3,000 tons of coal in her 6½ days' journey; her modern successor will exert 12,500 S.H.P. and use about 1,200 tons of oil fuel in 8¼ days. The older vessel carried 1,470 passengers on four decks 65 feet in width; the latter finds room for 2,200 on six decks 74 feet wide. The Campania was 41 ft. 6 ins. in depth to her upper or "strength" deck, the ratio of length to depth being 14·45; the Scythia is 37 ft. in depth to her upper deck, but has five decks above this as compared with the Campania's two. The girder ratio in the Scythia is about 11·3 to her bridge deck, so that she can obtain the required strength with relatively lighter scantlings. And on account of her greater depth and the increased number and height of her superstructures, as well as because the ballasting effect of her lighter machinery is not so conducive to stability, her beam is 9 ft. in excess of that of the famous Cunarder of 1893. The Campania could carry about 1,000 tons of cargo; the Scythia has a deadweight capacity for about eight times as much. The Scythia from the money-making point of view has the double advantage of less speed and the resources of present day naval science, but has to combat the inflated costs of all the materials and labour appertaining to her construction, maintenance, and operation.

As compared with these two 600-footers, we have the Mauretania steaming at 25 knots on about 4,200 tons of oil fuel, carrying 2,170 passengers and little or no cargo. To attain this speed her length was made 760 ft. and her breadth 88 ft., while her load draft is some 3½ ft. greater than that of either of the smaller vessels. The Campania's block coefficient of fineness was 0·65, the corresponding figures for the Scythia and Mauretania being 0·71 and 0·60 respectively.

A study of the qualities of these three vessels brings out clearly the fact that speed must be paid for in some way, the ameliorating effect of progress in naval architecture and marine engineering, and the great advance in the space and comfort provided for the modern travelling public.

PERCY A. HILLHOUSE.

# CHAPTER VII.

## JAPANESE SHIPBUILDING.

WESTERN maritime nations, and Britain in particular, will readily concede that seafaring is natural to an island race, but may not fully appreciate the physical and psychological values of the intensity with which water transport is associated with life in Japan. An Empire which contains some 3000 islands, whose people relied for centuries upon the water as their only means of communication, with whom fish is a staple article of diet, and who have always built and owned large fleets, should be, and is, a maritime nation in the most comprehensive sense.

The home trade shipping of Japan is typical, to a certain degree, of what the occidental is so fond of calling "The changeless East," so that the omnipresent junk not only strikes the imagination by its design, but harmonises with one's conceptions of appropriate conservatism, in a country where an unbroken Imperial lineage of twenty-five centuries is possible. The painstaking records of the Mercantile Bureau of the Imperial Department of Communications, indicate that, in 1908, out of some 27,100 sailing craft of less than 500 tons gross, no less than 21,700 were junks, but in 1919, out of some 42,500 sailing vessels of small size, only 10,500 were junks. These figures are evidence that the most ancient and conservative of handicrafts, even when exercised by the most conservative of craftsmen, is susceptible to change in form, and also show that no essential change has yet taken place in the mass of ships which provide the internal maritime communications of Japan.

For centuries the Japanese are believed to have been an adventurous and dominating maritime force in trade and war upon the Pacific, but, in the seventeenth century, a policy of isolation seems to have been forced upon Japanese statesmen by their interpretation of the effects of the propagation of Christianity. During two centuries, shipbuilding for ocean service was therefore forbidden, and maritime activities were entirely confined to small craft and home waters. However, greater knowledge of the true value of Western civilisation had an effect which was helped by the realisation of the fact that isolation might mean national suicide, and this edict of restriction was withdrawn in 1853. Habits consolidated by two hundred years of practice are not easily changed, and naturally, it took some time before the new policy had much practical effect upon overseas trade. In the late 'sixties, the Imperial Government only owned some twenty-one ocean-going vessels built in Japan, only one of which was a steamer, but twenty years later the exceptional enterprise and

business capacity of the founder of the Mitsubishi Company, placed maritime trade to foreign countries upon a firm foundation.

## Modern Developments.

It is, therefore, less than forty years since modern maritime enterprise found real expression in Japanese foreign-going ships, and expansion on modern lines began to grow alongside, but quite apart from, the fleet of little ships which were, and are, the life-blood of home trade. The complete story of Japanese shipping is lost in the ages, but that of its modern developments has been written within the business life of men who are still actively in control. The unforgotten interest and curiosity which attended my first associations with Japanese, during my work as an apprentice on the conversion of an iron steamer of the P. & O. line into a Japanese sailing ship, therefore related to the opening pages of that story. It is probable that no Western mind, any more than mine, had then any thought of the developments of which the present time bears record. The forcing effects of steam have given what may be justly called a mushroom growth to all commercial activities in other countries, but those of Japan require some more expressive adjective.

The development of foreign shipping in Japan is definitely expressed by the growth of its steam shipping, because it began too late to be influenced by sail, and, as far as can be ascertained from available data, is expressed by the following table:—

| | Gross tonnage of steamships owned, but exclusive of steamships registered in Colonies. |
|---|---|
| 1868 | 17,952 |
| 1878 | 70,805 |
| 1888 | 121,627 |
| 1898 | 464,246 |
| 1908 | 1,152,575 |
| 1918 | 2,310,959 (besides 171,366 tons registered in Colonies) |
| 1920 | 3,011,634 (besides 177,002 tons registered in Colonies) |

As will be inferred from the above figures, active development, as distinguished from making a beginning with steamship owning, really dated from 1885, when the great shipping company familiarly known to most people as the N.Y.K. was formed through the amalgamation of the Mitsubishi with another subsidised line. In 1888, the whole steam tonnage of Japan was only 120,000 tons, or about 2 per cent. of that owned in the United Kingdom, but last year it had increased to 18 per cent. The Nippon Yusen Kaisha line alone now possesses a capital of 58 million yen, owns 107 steamers which measure 500,000 tons gross, and stands high on the list of the great shipping concerns of the world.

The present position of Japanese shipping may be roughly summarised in the following fashion:—After two centuries of deliberate seclusion from foreign maritime trade, the Empire has placed itself, within forty years, in possession of a Navy which stands third on the list of the Navies of the world, and a fleet of somewhere about 1,000 steamers of about 3 million tons gross register engaged in overseas trade, but carries most of its native trade on a fleet of

somewhere about 50,000 small craft, the vast majority of which are sailing ships and whose gross tonnage is about 1½ million. The junks and little ships in the home trade of Japan must have been built in many and diverse unrecorded places throughout the centuries, but, before the war, more than 200 of these places were officially described as shipyards and during the war this number increased to over 300. The skill of the Japanese as workers in wood is above discussion, and the building capacity of these small plants is indicated by an output which seems to be of the order of 1,500 to 2,000 ships a year. There is no available information as to the rate of decrease in the number of small wood shipyards since 1919, but it is not likely to recede to pre-war standard unless practical policy should move towards the use of present war-created plant in modernising home-trade shipping.

## Steel Shipbuilding.

Modern steel shipbuilding is of even more recent development than that of modern Japanese ship-owning, and is really the work of one generation, which was largely assisted by British teaching and management. During the decade prior to 1901, the annual output from Japanese yards did not exceed 20,000 tons.

In 1908 it rose to close upon 60,000 tons, and this output was not exceeded until the beginning of the war-production period in 1915, reaching the neighbourhood of 70,000 tons in 1919. Japanese war production was quite as extraordinary as that in any country, having regard to pre-war production, dependence upon imports of material, and the character of the available pre-war plant. Before the war boom, Japan possessed six yards with berths on which ships of more than one thousand tons could be built; in 1914 these yards had a paid-up capital of 23 million yen and employed 26,000 workmen. In 1918 there were 57 yards and 157 berths available for building ships over 1,000 tons; the shipbuilding companies had a paid-up capital of 110 million yen, employed roughly 100,000 workmen, and twelve of these yards were devoted to building wood ships. This proved to be the maximum increase in productive power and the output reached a maximum at that time of practically 700,000 tons per annum, or ten times the pre-war maximum. It is impossible to disentangle pre-war production from its association with naval work, but war-time results obviously mean a great advance in productive power per unit of output. It might be assumed that the difference is roughly measured by the fact that the war output was accomplished by only four times the pre-war number of men.

## Labour Conditions.

The average working day was ten hours and the average wage for skilled, unskilled and apprentice labour (on the basis of 2*s.* 6*d.* to the yen) seems to have been about 6s. a day, an increase of fully 100 per cent. on the 1914 standard. On the assumption made by Japanese shipbuilders that the British output per man is twice that

of his Japanese confrère, a computation which seems excessive from the point of view of a mere observer, the relative cost per unit of output by skilled Japanese labour in 1918 would be about 12*s.* a day. The average cost in British yards of skilled, unskilled, and apprentice labour, on the basis of the total wages per week, divided by the total number of employees in a large yard, and assuming that each man worked ten hours a day for five days a week, would be about 9*s.* a day in 1916, 14*s.* in 1918, and 16*s.* in 1920. This expression of available data does not profess to be accurate, but it does give an indication of the respective costs per unit of production in Britain and Japan. I am indebted for many of the foregoing and following Japanese statistics to a paper read last year by Mr. Y. Yamamoto of the Imperial Mercantile Bureau, and in thanking him and his translator, give the British public an opportunity of placing in conjunction with the existing state of trade Mr. Yamamoto's statement that the average price per ton deadweight of Japanese merchant ships increased from 110 yen to 810 yen between 1914 and 1918.

### The Permanence of War Developments.

It is, of course, impossible to predict what proportion of the war developments will form a permanent asset to the nation, but it is known that thirty-five of the fifty-seven yards, including the twelve yards which built wood ships, had gone out of business at the beginning of last year. It is evident, however, that the fact that all the pre-war yards have made extensive additions to their plant during the war, and that the development appropriate to many normal years has been condensed into three or four, will form an important factor in the future position of Japan as a shipbuilding nation, and in the chances of life for the new yards. It has to be remembered also, that the period of tutelage had closed before that of war commenced, and that the recent Japanese expansion and development in shipbuilding and engineering power are due to Japanese brains and Japanese energies.

It is also an important factor in considering the relation of the present to the future, that such a concern as the great Asano yard was conceived, developed, and put into operation under the same influences and conditions. The ground on which the Asano works now stand was partly under water in 1916, yet a yard which extends to 180 acres, and is laid out on the grand scale of ten berths to carry steamers over 600 ft. in length, was so rapidly constructed and organised that its first ship was launched in 1917. In 1920 the yard with its concrete building berths, modern plant, absence of uprights, tower cranes, railways, etc., gave greater impression of size, spaciousness, and extreme modernity in lay out and facilities for the production of freight tonnage, than that given by any other yard of the type which had previously been under my inspection. A steel rolling mill is already set on adjacent ground, and it is understood that the Asano Company propose to lay down engine works, boiler shops, dry docks, etc., on a similar grand scale to that of the yard.

The Mitsubishi yard at Nagasaki, which is probably the oldest and most important yard in Japan, the Kawasaki yard at Kobe, the Osaka Iron Works, the Yokohama Dock Co., and others, are each in their way "eye-openers" on account of their great size, facilities for the output of the largest craft, completeness of equipment for building reciprocating engines and turbines, cutting reduction-gear wheels, electric-motor construction, boiler making, foundry work, forging, etc., on the lines of self-contained production. These are features which impress even those who are case-hardened by custom, but they also form a reminder that past development of Japanese shipbuilding has been under Imperial auspices, for Imperial purposes and supported by public money.

At least seven yards in Japan might now be called great yards, most of which seem to have developed on similar lines and to represent an unnecessary multiplication of individual subsidiary plant, such as forges and machine shops, when considered in relation to gross output of merchant steamers under competitive conditions, but of course the trail of Government production is over all the pre-war yards. The magnitude of Japanese shipping interests is brought out by the fact that they possess two large pontoon docks, twenty-seven slipways and sixty-two dry docks of all sorts and sizes; ships of over 400 ft. in length can be docked in eleven of them, while one dock can take ships 650 ft. long, and another 700-ft. ships.

During the war, the production of shipbuilding steel was pooled, and the combined interests of the Mitsubishi, Kawasaki, Asano, and Government seem to have been able to overtake about one-fourth of the war requirements. This obviously affords a substantial nucleus for post-war development.

During the war, there was also a marked expansion in the production of auxiliary machinery and small parts in Japan, so that the war has had an undoubted effect not only in developing personal enterprise, but in causing a rapid advance in the direction of converting Japan into a self-supplying shipbuilding country.

### Standard Ships.

Making of records agree so little with our ideas of the Orient that it may be useful to draw attention to the fact that, under modern methods such as are expressed in the Asano yard and which are now common to all the larger yards, it became commonplace to turn out standard ships 450 ft., 475 ft., and 495 ft. long, as the case may be, in from 4 to 4½ months on the berth. It is clear from the war records that three months was quite a common interval between the laying of keel and delivery of standard ships in Japan, while the Kawasaki yard claimed the world's record for rapid production, when they built a 9,000-ton deadweight ship in twenty-three days and delivered it in thirty days.

The Japanese also made good use of the advantage to be derived from repetition work, as the war records show that the Kawasaki yard turned out fifty-seven ships of 9,000 tons deadweight, the Uraga Co. nineteen of 6,800 tons, the Osaka Iron Works seventy ships of four

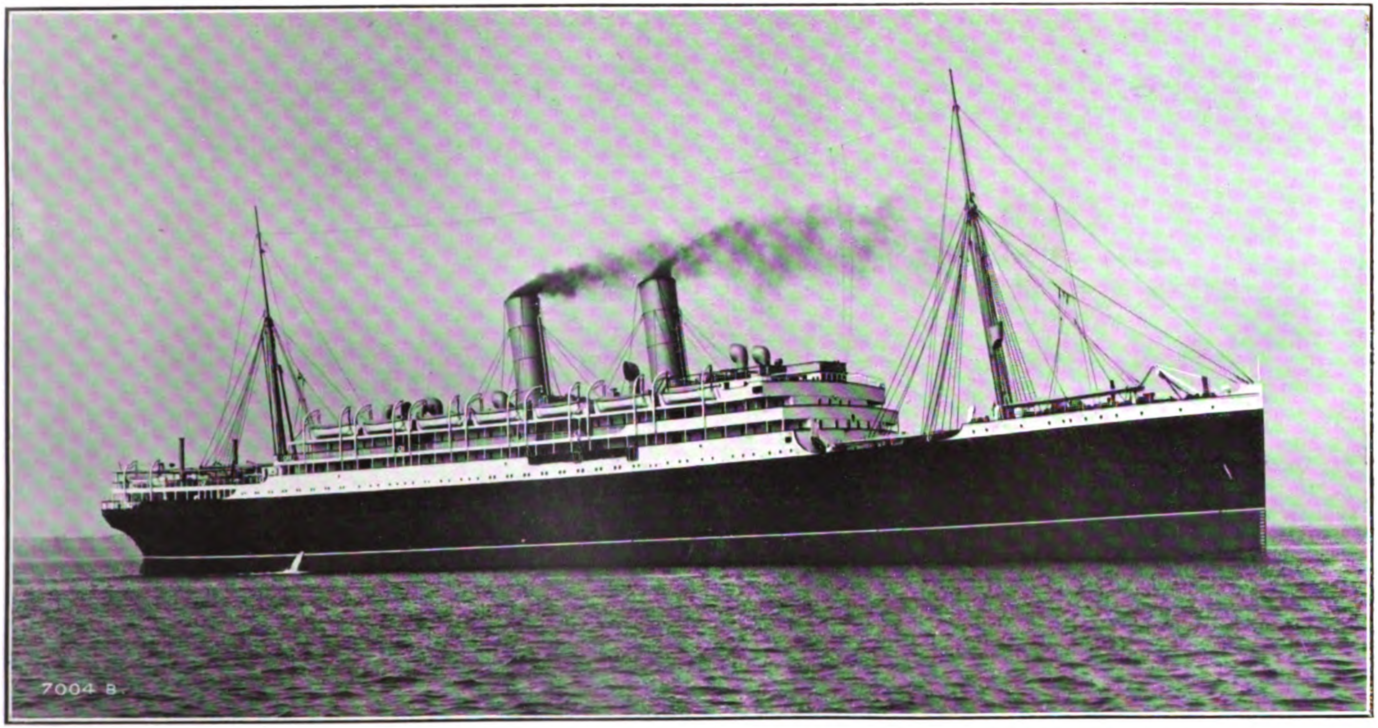
types, and so on through a list which shows roughly six types for 236 ships and nothing but sister ships in each of the smaller yards.

These achievements are rendered more remarkable by the fact that they were obtained by a controlling personnel which was trained under the disabilities of Japanese education. It is true that Japanese technical education is of the most complete and highly developed character, but the need to learn anything from 5,000 to 20,000 Chinese characters or symbols obviously involves the expenditure of much time and means more intense development of the mnemonic cells than powers of reasoning or initiative. It is also true that an attempt is made, during the educational period, to implant practical knowledge by means of technical laboratories in the Universities, but the fact remains that perhaps five unnecessary years are spent in education, and that real practical training has to begin after the plastic period and after the mind has been set in a scholastic mould.

A general review of impressions left by necessarily imperfect opportunities of observing the shipping trade of Japan, resembles those left by similar observation of Japanese roads. Magnificent wide thoroughfares with electric tramways and motor cars are to be found in the great centres of population, associated with endless miles of narrow highways without surface, on which myriads of human beings serve the needs of the community by hauling freight and passengers, while an occasional motor car jostling through the pack causes misfortune to a ricksha, in much the same way that the great liner jostles through the junks upon the crowded highways of the sea, with occasional misfortune to a junk.

The wonderful energy and adaptability which have developed such intense modernity in parts, while the great mass of Japanese thought and action continues to move on paths which are very ancient, might be regarded as natural to a nation which commences a book at the last page. A part is less than the whole, but may be greater in value, and all things are possible to a race of such proved achievements under impulse from a part. What will happen should the mass develop under the impulse to be derived from the adoption of a Roman alphabet and of modern internal communications by land and water?

J. FOSTER KING.




LINER EMPRESS OF BRITAIN OF CANADIAN-PACIFIC OCEAN SERVICES, LTD.

Built and engined by the Fairfield Shipbuilding & Engineering Co., Ltd., Glasgow.
Reconditioned and fitted for oil-fuel burning in 1920.

# CHAPTER VIII.

## THE WORLD'S RESOURCES OF PETROLEUM FUEL OIL.

FROM time immemorial the shoemaker has held with sincerity to his simple creed, "There's nothing like leather." The good oilman of to-day professes a similar creed with regard to his own commodity, and with like sincerity, but expresses himself less directly thus: "The surest index to the development of civilisation is the extent to which natural forces and natural resources are utilised. The last century saw mankind adopt for his personal comfort and industrial advantage coal and iron deposits which had lain unused for many centuries. The easily accessible high-grade coal has been consumed with prodigal waste and this century would have paid dearly for this lack of conservation if it were not for the development of our tremendous petroleum resources. The appalling waste of our coal resources and the advancing prices of coal, coincident with the vanishing of the supply, have taught us that our petroleum resources must be conserved; that we must apply all of our mechanical skill and scientific knowledge to the determination of higher uses for petroleum products." * This is well put and it needs only to be added that there has often been, and still is, a great waste of oil in the wells and on the fields, as well as in the manner of its use.

The newspaper Press—general as well as technical—keeps us continually reminded that great as the increase has been in the use of petroleum oil, which has now become one of the world's essential and primary products, there is no stopping on this road, and that as we return to a more normal economic condition, the consumption of petroleum will be greater and not less. We are told that this is the "oil age," and then speculation begins: How long will the oil age last and what will follow?

The experts for the most part tell us that oil can only supplement and not supersede coal. Its production will continue to be relatively small in proportion to the total coal output. Oil has its special uses, not always in supersession of coal but for new services as in aircraft or in relief of horse traction by motor lorries and automobiles. The oilman, being himself something of a scientist, or rubbing shoulders with scientific men, knows quite well that his fuel is not the only fuel, although he can make good his case, with many illustrations from war experience, that fuel in the liquid form has a flexibility and economy of use for certain services, especially in ships, with which lump coal, hand-fired and manipulated, cannot compare.

* Stephen Andros, "Petroleum Handbook," Chicago, 1920.

Those who predict either a comparatively short life or a long life for natural petroleum agree in this—that coal will still be the main fuel in quantity even in the oil age, and that when natural supplies of petroleum are nearing exhaustion, or earlier, fuel in the liquid form will be distilled from coal, shale, and other bituminous substances, and finally that the use of solid coal will be replaced, to the largest possible extent, by the liquid and gaseous products of coal. Oil, of primary or secondary origin, will live on until the chemist, the engineer, the physicist, and the inventor shall have further harnessed the tides and the waterfalls, or learned to store the energy of the solar rays, or penetrated more deeply into the earth's crust to reach new or additional sources of heat and power.

The purpose of this contribution is to bring together from many scattered sources in text-books and journals, which the average user of oil may not have the time or opportunity himself to collate, a few of the principal facts and figures relating to the past and present production and the distribution of petroleum oil, especially of the type known as "heavy fuel oil" used for marine purposes. After reviewing the statistics of fuel and coal production and use, an attempt will be made to deduce such general conclusions as an intelligent layman, or non-expert, can arrive at without putting on the mantle of the prophet or assuming the *rôle* of the soothsayer.

## The Characteristics of Oil Fuel.

Without entering deeply into the technicalities of specifications, it is necessary to describe briefly the main characteristics of the heavy fuel oils used in steam boilers for steam raising, and for Diesel engines, respectively. The principal specification points may be put conveniently in tabular form.

Principal Specification Points of Fuel Oils.

| | Service. | Specific Gravity at 60° F. | Beaumé. | Flash point. | Asphalt per cent. | Sulphur per cent. | Ash per cent. | Water per cent. |
|---|---|---|---|---|---|---|---|---|
| A | Diesel Engines | 0·850 to 0·925 | 34 to 21 | 150° F. and over | Up to 8% | — | 0·05% | Up to 2·0% |
| B | Do. | 0·900 | 25 | — | 2·5% | 2·0% | 0·02% | 0·5% |
| C | Under boilers | 0·925 to 0·965 | 21 to 15 | 150° F. and over | — | Up to about 3% | — | 0·09% to about 3% |
| D | Do. | 0·952 | 17 | 150° F. and over | — | 2·0% | — | 2·0% |

Fuel oil has a calorific value ranging from about 18,000 to 19,400 British Thermal Units per lb. That of coal may be taken approximately as from 11,000 to 14,000 B.T.U.'s per lb.

The figures at A of the table are those published recently by Dr. Harold Moore (*Motor Ship*, March, 1921), as representing a fuel suitable for a true Diesel engine, and in his "Liquid Fuels for Internal-Combustion Engines" (2nd edition, 1920) he states that

"Oils containing less than 10 per cent. of soft asphaltum give general satisfaction in Diesel engines, but above this figure, the oils are liable to cause trouble." Asphalt is usually regarded as not detrimental in steam-boiler fuels, but it is stipulated that for semi-Diesel or low-compression types of internal combustion engines, asphalt should be below 1 per cent.

The figures at B are those given by a leading firm of engine manufacturers as a very good fuel oil for their Diesel engines. It will be noticed that experts are not entirely agreed as to asphalt.

The specification at C represents approximately the range of average commercial oil bunker supplies, which are seldom sold other than to a very general specification of good quality, except in respect of flash-point of not less than 150° F., which must be guaranteed to meet Board of Trade and Lloyd's requirements.

The specification at D gives an average of an analysis of some half a dozen fuel oils specified in a catalogue of a manufacturer of oil-burning equipment.

A useful report on oil bunker specifications will be found in Bulletin No. 1 of the U.S. Fuel Administration, Oil Division (October, 1918), as revised by Bulletin No. 5 (1921) containing a Committee Report on the standardisation of Petroleum Specifications.

No reference is made in the table to any standard of viscosity or fluidity of oil at low temperatures, although a standard for that purpose is prescribed in Navy specifications. The use of the more viscous oils, which may have excellent calorific values, necessitates the promotion of fluidity by steam coils in tanks and bunkers of ships employed in the colder climates; and merchant ships, as well as warships to a large extent, have to be equipped accordingly. Generally speaking the more viscous oils are those of an asphaltic base, *e.g.* such as are obtained from Mexico in particular. Oils of a paraffin base, especially if the paraffin be removed at the refinery for sale as wax, are usually of a less viscous nature. It will be noticed that the main distinction between the grades for use under boilers and in Diesel engines, respectively, is in regard to "gravity" or "Beaumé." The American Beaumé scale is fairly well known in this country. The Beaumé scale begins at 10 which is equivalent to a specific gravity of 1, and the Beaumé degree goes up as the weight goes down, *e.g.* 34 Beaumé = 0·850 gravity, and 17 = 0·925, the familiar formula for converting Beaumé (B) to gravity being $\frac{140}{130+B}$ = specific gravity.

Heavy oils suitable for Diesel engines can be and frequently are used, more or less unavoidably or in special cases, under steam boilers, although such a practice is not the most economical use of the oil. A small point of nomenclature may here be mentioned. Manufacturers of Diesel engines frequently use the term "crude oil" as describing the fuel on which their engines will run. The oil actually used is seldom, in fact, the plain crude oil as it comes from the well, which is the sense in which the producer or refiner uses the term "crude." Crude oils of exceptional character, or in certain localities and circumstances, are used as "fuel," *e.g.* on oil fields, etc. The oil used as "heavy fuel" for marine purposes of "under boiler" or

### PRODUCTION OF CRUDE OIL IN VARIOUS REGIONS.

| Country. | Crude production of Petroleum in— | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1860. | 1870. | 1880. | 1890. | 1900. | 1910. | 1913. | 1919. | 1920. |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| NORTH AMERICA: | | | | | | | | | |
| Atlantic Seaboard | 70,000 | 730,000 | 3,550,000 | 6,170,000 | 7,940,000 | 16,750,000 | 18,170,000 | 34,770,000 | 42,890.000 |
| Pacific Seaboard | — | — | 10,000 | 50,000 | 670,000 | 11,230,000 | 15,040,000 | 15,630,000 | 16,260,000 |
| MEXICO | — | — | — | — | — | 540,000 | 3,840,000 | 13,000,000 | 24,330,000 |
| TRINIDAD | — | — | — | — | — | 20,000 | 70,000 | 260,000 | 300,000 |
| SOUTH AMERICA: | | | | | | | | | |
| Atlantic Seaboard | — | — | — | — | — | — | 20,000 | 210,000 | 280,000 |
| Pacific Seaboard | — | — | — | — | 40,000 | 180,000 | 280,000 | 350,000 | 370,000 |
| ASIA: | | | | | | | | | |
| India, East Indies, Persia, Japan, etc. | — | — | — | 30,000 | 570,000 | 2,610,000 | 3,100,000 | 4,760,000 | 5,160,000 |
| AFRICA: | | | | | | | | | |
| Egypt | — | — | — | — | — | — | 10,000 | 230,000 | 150,000 |
| EUROPE: | | | | | | | | | |
| Russia | — | 30,000 | 410,000 | 3,980,000 | 10,380,000 | 9,640,000 | 8,610,000 | 4,580,000 | 3,520,000 |
| Roumania | 1,000 | 10,000 | 20,000 | 50,000 | 230,000 | 1,310.000 | 1,870,000 | 920,000 | 1,030,000 |
| Elsewhere | — | — | 30,000 | 110,000 | 380,000 | 1,920,000 | 1,240,000 | 920,000 | 850,000 |
| Total | 71,000 | 770,000 | 4,020,000 | 10,340,000 | 20,210,000 | 44,200,000 | 52,250,000 | 75,630,000 | 95,140,000 |
| Percentages of increase | — | 1,000 over 1860 | 425 over 1870 | 157·2 over 1880 | 95·3 over 1890 | 118·8 over 1900 | 18·2 over 1910. | 44·9 over 1913 | 26 (over 1919) or 117 (over 1910) |

NOTE.—The production of crude oil in the United States as given in American oil journals for the first 3½ months of 1921 shows a fairly steady daily average of approximately 185,000 tons divided as follows:—Eastern States about 17,000 tons; California 47,000; Mid-continent and Southern States 121,000 tons.

The figures in the above table may be taken as approximately accurate, allowing for the more or less exact methods of various tabulators, *e.g.* in converting "barrels" to tons, etc. This is often done roughly by taking seven barrels to the ton without reference to the varying specific gravities of particular oils. The later figures for Russia, and in one or two other instances where authoritative returns are not published, have had to be partly estimated.

"Diesel" grades is, in fact, usually a "residual oil," *i.e.* what is left of the crude oil after the lighter fractions for motor spirit, illuminating purposes, etc., have been removed by distillation. Heavy fuel oil goes by the name of "Mazout" in France, Russia, and some other countries, as "Pacura" in Roumania, and in Italy by the somewhat confusing name of "Nafta," which in America and elsewhere denotes the lightest oil fraction. The Institution of Petroleum Technologists is giving attention to the question of standardising nomenclature, and what is still more important, the standardising or correlating of systems and instruments for ascertaining and recording flash points, gravities, fluidities, etc. International co-operation will be necessary to obtain any large measure of success in this direction.

## The World's Production of Oil.

We may next consider the world's production of crude oil and endeavour to form some opinion of the aggregate quantities used in particular countries as heavy fuel. The table on the preceding page shows the world's production of crude oil expressed in tons.

## Oil Output of the United States and Mexico.

Tables on this and the following page give the production of crude oil and the home consumption and export of fuel oil, for the two countries which are at present the world's largest producers of heavy fuel oil, viz. the United States and Mexico. A special feature of interest in the United States table is the large import into that country of Mexican crude oil for refining and particularly for the production of heavy fuel oil. While the United States exports large quantities of lamp oil and motor spirit to other parts of the world, her export of fuel oil is largely Mexican residual, or a combination of Mexican with the indigenous product.

United States Petroleum Statistics.

| Year. | Crude. | | Total. | Estimated home consumption of Amercan and Mexican fuel oil (including coastwise bunkers). | Exports of fuel oil. | | Total. |
|---|---|---|---|---|---|---|---|
| | Home production. | Mexican imports. | | | Cargo. | Foreign voyage bunkers. | |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| 1917 | 44,700,000 | 4,900,000 | 49,600,000 | 17,500,000 | 3,800,000 | 900,000 | 4,700,000 |
| 1918 | 47,500,000 | 5,600,000 | 53,100,000 | 21,500,000 | 4,200,000 | 1,000,000 | 5,200,000 |
| 1919 | 50,400,000 | 7,500,000 | 57,900,000 | 23,700,000 | 2,000,000 | 2,100,000 | 4,100,000 |
| 1920 | 59,000,000 | 16,000,000 | 75,000,000 | No details. | 3,000,000 | 3,750,000 | 6,750,000 |

Note.—The figures are approximate only, having been compiled from a number of published reports (not always in complete agreement) and converted from barrels. The home fuel oil consumption does not include American or imported Mexican oil used in the "crude" state. Reliable statistics have not been obtained for this item. Much the largest proportion of the home fuel consumption is for manufacturing and public utility plant. Twenty-five per cent. of the fuel production is used by railways.

MEXICAN PETROLEUM STATISTICS.

| Year. | Production. | Exports (figures are approximate). | | | |
|---|---|---|---|---|---|
| | | As cargo. | | As bunkers. | Total. |
| | | United States. | Elsewhere. | | |
| | Tons. | Tons. | Tons. | Tons. | Tons. |
| 1916 . . . . | 6,040,000 | 3,130,000 | 1,040,000 | 180,000 | 4,350,000 |
| 1917 . . . . | 8,210,000 | 4,480,000 | 2,390,000 | 300,000 (est.) | 7,170,000 |
| 1918 . . . . | 9,550,000 | 5,670,000 | 2,240,000 | 330,000 (est.) | 8,240,000 |
| 1919 . . . . | 12,990,000 | 7,910,000 | 3,210,000 | 490,000 (est.) | 11,610,000 |
| 1920 . . . . | 24,330,000 | 16,570,000 | 5,070,000 | 870,000 (actual) | 22,510,000 |
| 1921 . . . . (6 months) | 15,500,000 (approx.) | — | — | — | — |

Bunkers are usually omitted from published export figures. A closely approximate figure for 1920 has been obtained and used as a basis for calculation of previous years.

In 1920 Mexican exports, of which 97½ per cent. was crude or fuel oil, went direct as follows:—

| | | | |
|---|---|---|---|
| United States . . . . . . . . . | 78 | 94 | per cent. |
| Elsewhere in New World . . . . . | 16 | | |
| Great Britain . . . . . . . . . . | | 4⅕ | " |
| Balance to Europe and North Africa . . | | 1⅘ | " |
| | | 100 | |

The total United States commercial bunkers supplied in 1919 and 1920 are given in round figures in the following table:—

UNITED STATES COMMERCIAL BUNKERS.

| Commercial bunkers supplied at— | 1919. | | 1920. | |
|---|---|---|---|---|
| | American oil. | Mexican oil. | American oil. | Mexican oil. |
| | Tons. | Tons. | Tons. | Tons. |
| Gulf ports . . | 100,000 | 200,000 | 309,000 | 280,000 |
| Pacific ports . . | 1,110,000 | — | 1,800,000 | — |
| Atlantic ports . | 47,000 | 1,040,000 | 30,000 | 2,800,000 |
| Totals . . . | 1,257,000 | 1,240,000 | 2,139,000 | 3,080,000 |

## THE VARYING PROPORTIONS OF LIGHT AND HEAVY FRACTIONS IN CRUDE OIL.

In attempting to make an estimate of the world's resources available as heavy oil fuel for marine purposes, it is necessary to remember that crude oils vary very widely in respect to the proportions of "light" and "heavy" fractions which they contain. Standard text-books, such as the well-known Treatise on Petroleum by the late Sir Boverton Redwood, and refinery statistics published in the United States in particular, indicate the principal differences.

An analysis of a number of United States crude oils is stated to give an average of about 40 per cent. of light products boiling at under 300° C. (*i.e.* motor spirit and lighting oils), against about 60 per cent. of heavy products boiling at over 300° C., such as fuel and gas oil, lubricating oil, wax, pitch, etc. The loss in refining is included in these figures. Certain Mexican analyses give an average of about 20 per cent. light to 80 per cent. heavy; Roumanian about 40 per cent. light to 58 per cent. heavy.

It must be pointed out that a chemist's analysis of the proportions of various oils which a given crude oil may contain does not necessarily correspond with that which, in commercial practice, will be produced at the refinery. It is, of course, the aim of every refiner and producer of oil to attain as nearly as possible to the ideal of taking out of the crude oil all the constituents that possess a separate use and market value, but the necessity either of using the nearest attainable fuel for local purposes, or the variations in the requirements and accessibility of the world's markets for various products, may lead to products being used less efficiently than would otherwise be the case, *e.g.* to light fractions being left for consumption as part of a heavy fuel, or to superior grades of heavy fuel being used under boilers instead of in Diesel engines. All these matters tend to right themselves as the use of oil and the means of transportation and marketing are developed. Much can still be done, however, to attain the ideal of economic use by closer co-operation between the manufacturers of engines and the oil refiners and distributors.

Generally speaking, and subject to special considerations, it is very desirable that a good average standard of oil, widely available, should be specified for Diesel engines, rather than some specially selected grades less available, although the latter might give a somewhat higher efficiency. Except where ships may be engaged in special trades, what the owner normally requires for world-wide-moving ships is to obtain supplies at any port of bunkering, and in the long run the interests of the engine builder and the oil supplier must be to co-operate to meet that requirement. A suggestion of this nature as to conditions generally desirable is obviously open to modification for special cases.

## Oil as a Substitute for Coal.

Half the world's crude oil production—now in the neighbourhood of 100,000,000 tons—can be considered as available in the form of heavy fuel oil. We can assume that 1 ton of this fuel, when used under boilers, will replace 1½ tons of coal, and in Diesel engines it would do the work of three to four tons. Taking at a very moderate estimate its many collateral advantages—saving of weight, man-power, time, etc.—we shall certainly not be putting the case too favourably for oil fuel in estimating that it is economically the equivalent of at least twice its weight in coal. Hence the world's present annual supply of heavy fuel oil alone is the equivalent of at least 100,000,000 tons of coal. Any proportional increase in use for Diesel engines, as

compared with steam raising, would increase the factor of equivalence in favour of oil. As already indicated, heavy oil is largely used, especially in the countries of origin or adjacent countries, for railway and industrial purposes as well as for steamships.

The next table gives a comparison of the world's coal and oil production so far as figures are obtainable, and also indicates the quantities of coal supplied as bunkers.

WORLD'S COAL AND OIL PRODUCTION COMPARED.

(In Millions of Tons.)

| Year. | Coal. | | | | Oil. | |
|---|---|---|---|---|---|---|
| | U.K. | U.S. | Elsewhere. | Total. | Quantity. | Percentage of coal production. |
| 1913 . . . . | 287 | 517 | 537 | 1341 | 52 | 3·9 |
| 1914 . . . . | 266 | 466 | 476 | 1208 | 54 | 4·5 |
| 1915 . . . . | 254 | 482 | 454 | 1190 | 57 | 4·8 |
| 1916 . . . | 256 | 535 | 479 | 1270 | 61 | 4·8 |
| 1917 . . . . | 248 | 591 | 497 | 1336 | 68 | 5·1 |
| 1918 . . . . | 228 | 621 | 483 | 1332 | 69 | 5·8 |
| 1919 . . . . | 230 | 494 | 446 | 1170 | 75½ | 6·5 |
| 1920 . . . . | 229 | 586 | 485 | 1300 | 95 | 7·3 |

Coal supplied as bunkers:—

In U.K.—1913—21,023,693 tons. 1920—13,840,360 tons.
„ U.S. . . . . . . . . . 1920— 7,238,575 „

## SHIPS WITH INTERNAL-COMBUSTION ENGINES.

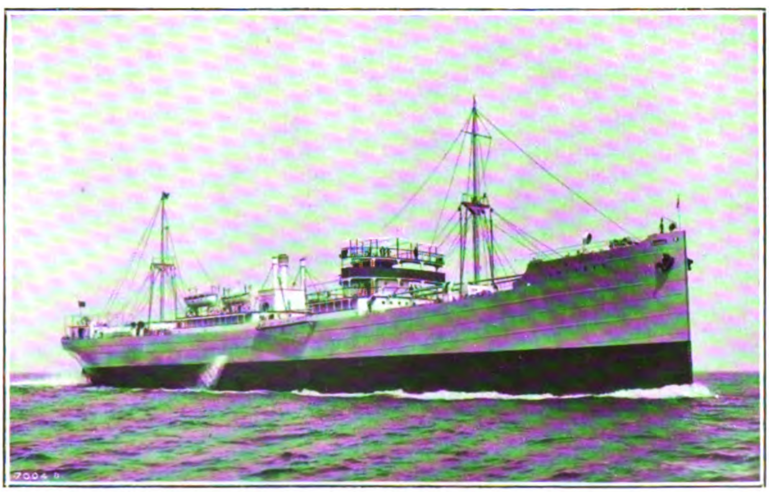
The table appended gives statistics as to the number of self-propelled ships afloat as per Lloyd's Register 1914–15 and 1921–22, showing the number of steamers using coal and oil under boilers and the number driven by internal-combustion engines.

TOTAL SELF-PROPELLED VESSELS OF VARIOUS COUNTRIES (*vide* LLOYD'S REGISTER).

| Year. | Number. | Gross Tonnage. | Fuel. |
|---|---|---|---|
| 1914-15 . . | 23,790 | 43,859,877 | Coal |
| | 364 | 1,310,000 | Fuel oil |
| | 290 | 234,000 | Internal combustion |
| | 24,444 | 45,403,877 | |
| 1921-22 . . | 24,450 | 44,786,325 | Coal |
| | 2,536 | 12,797,000 | Fuel oil |
| | 1,447 | 1,263,000 | Internal combustion |
| | 28,433 | 58,846,325 | |

MOTOR SHIP SEMINOLE, FOR THE ANGLO-AMERICAN OIL COMPANY.

Built and engined by Messrs. Vickers, Ltd., Barrow-in-Furness.



MOTOR SHIP YNGAREN, FOR THE TRANSATLANTIC STEAMSHIP CO., SWEDEN.

Built and engined by Messrs. W. Doxford & Sons, Ltd., Sunderland.

The table below shows the number of motor ships under construction at the end of June, 1921.

MOTOR VESSELS UNDER CONSTRUCTION, JUNE 30, 1921.

| | No. | Gross tonnage. |
|---|---|---|
| United Kingdom . . . . | 57 | 241,003 |
| British Dominions . . . | 2 | 500 |
| United States . . . . . | 8 | 32,119 |
| Europe (excluding Germany) | 116 | 229,322 |
| Totals . . . . . . . | 183 | 502,944 |

Throughout the world there were 7,179,778 gross tons of shipping under construction.

The returns issued by Lloyd's Register for the June quarter of 1921 show that, at the end of that period, there were a total number of 183 motor vessels, having an aggregate gross tonnage of 502,944, under construction in different countries in the world, excluding Germany, for which country no figures were available. Of this number, 57, with a total gross tonnage of 241,003, were being built in the United Kingdom, and although this tonnage was somewhat less than the corresponding figure for the end of the March quarter, which was 263,180 (66 ships), it still formed nearly 7 per cent. of the total tonnage building in this country, and was but little less than the total tonnage of motor vessels under construction in all other countries of the world put together. At the time under consideration, second place with regard to the construction of motor vessels was taken by Denmark, with Sweden a close third, the tonnages under construction by these two countries being 63,710 (17 vessels) and 62,075 (18 vessels) respectively. Other countries with notable quantities of motor vessels in hand were Italy with 40 ships making 48,446 gross tons, the United States with 8 ships making 32,119 gross tons, Norway with 12 ships making 20,976 gross tons, and Holland with 11 ships making 17,505 gross tons. From the foregoing figures it will be seen that the Scandinavian countries, collectively, were responsible for the construction of 47 motor ships with a total gross tonnage of 146,761, this tonnage representing over 50 per cent. of the total tonnage of all classes of shipping being built in those countries at the time; the percentage, it should be noted, is much larger than the corresponding figure previously given for this country. It may also be of interest to add that, for the whole world, the proportion of motor vessels under construction on June 30 last was about 8 per cent. of the total tonnage building.*

## OIL-FIRED STEAMERS.

Mr. Mark Requa (late Head of the Oil Division of the United States Fuel Administration) stated in November, 1920, "according to Lloyd's, 16·3 per cent. of the world's tonnage is on oil fuel and a further 1·7 per cent. is using oil fuel in Diesel engines." Statistics recently compiled in the United States from official sources show a total of 1,367 vessels in the American merchant marine, of 500 tons gross and over, equipped for burning oil fuel in 1920, as against 762

* The subject of the development of the Diesel engine is dealt with in a separate chapter.

in 1919. The 1920 gross tonnage is nearly 6,500,000 tons, and the 1919 tonnage about 5,500,000 tons. Of the total number of vessels equipped for burning oil fuel in 1920, 946, with a gross tonnage of 4,334,428 tons, were Shipping Board vessels. In reviewing figures as to oil and coal burning tonnage, it must be remembered that the division is not necessarily permanent, many vessels are convertible and are frequently converted from oil to coal burning and *vice versâ*, according to the exigencies of their movements and the distribution and relative cost of coal and oil bunkers in the world's bunkering ports.

Very approximately it may be estimated that, in 1920, the total consumption of oil for ships' bunkers (excluding Russian local consumption) was in the neighbourhood of 12,000,000 tons, of which probably about 3,000,000 tons may be assigned to the world's warships, leaving 9,000,000 as the approximate consumption of the world's Mercantile Marine. The U.S. Shipping Board vessels alone would need in ordinary active employment, if running on oil, upwards of 4,000,000 tons per annum of heavy oil fuel. The total annual requirements of the United States for fuel oil for marine purposes have been recently estimated as high as about 6,000,000 tons. Obviously oil-bunkering figures would rise or fall with employment or stagnation in the movement of tonnage. Fuel oil bunkers can now be obtained at practically all the principal bunkering ports in the world, a list of which is given in the Merchant Shipping Appendix.

From the present trend of shipbuilding, it may be inferred that in the next five to ten years there will be a great increase in the use of oil both for steam raising and for Diesel engines. Marine authorities have pointed out the wastefulness of under-boiler consumption of oil as compared with motor ships. It is claimed for the latter, that their cargo capacity is increased by over 12 per cent. owing to the elimination of boilers and condensers and the reduction in bunkers. It seems probable—short of any remarkable new departures not foreseeable—that Diesel engines, constantly improving, will be more and more adopted, at least in ships of moderate tonnage. For ships of larger tonnage, oil will be increasingly adopted in vessels where its advantages are undoubted, *e.g.* in the passenger ship *de luxe*. Tank steamers are already largely operated on oil, and in other vessels oil and coal will probably, for some time yet, be regarded as convertible fuels to be used either in combination or alternatively according to circumstances.

As regards warships, it is common knowledge that the principal Navies of the world have adopted oil as their main fuel. An announcement to the effect that the British Navy was gradually becoming all-oil burning was recently made in Parliament.

The following extract from a Memorandum accompanying a recently published despatch from the Marquess Curzon to the British Ambassador at Washington is of special interest regarding the extending use of oil by Great Britain and her Navy, and the sources from which the demand is met:—

Great Britain is, next to the United States and (in normal times) Russia, the largest consumer of oil in the world. Over 90 per cent. of her Navy is oil-fired (as compared with 45 per cent. before the war), as is a rapidly increasing proportion of her merchant marine. Her present home resources consist of one well giving a

daily production of one ton, and the Scottish shale fields, which yield about 165,000 tons of oil products annually.

In 1920 Great Britain imported about 3,368,600 tons of oil (motor spirit, kerosene, fuel oil, lubricants, etc.), of a total value of £67,000,000. Of this, 61 per cent. in quantity and 68 per cent. in value came from the United States, 37 per cent. in quantity and 30 per cent. in value from other foreign countries, and 2 per cent. in quantity and 2 per cent. in value from British possessions. During the war the annual imports of petroleum rose as high as 5,160,000 tons.

Notwithstanding the steady increase in marine expenditure it may be expected—and this is obviously desirable in the general interest of consumers, manufacturers and producers—that spasmodic or abnormal changes will not occur in normal circumstances, but that ship and engine policy will proceed by stages more or less in keeping with the development of oil production and distribution.

## Supplies of Fuel Oil.

As regards the relative cost of coal and oil, the efficiency of consumption in favour of oil for motor ships is such that oil users will probably not hesitate to turn to that source of power, nor need it be doubted that supplies will be available at all the principal bunkering ports as soon as they are required. Also, on the whole, it may be expected that those who decide to use heavy oil for steam raising for marine purposes will be able to get their supplies at prices that, taking all collateral advantages into account, will enable them to use the fuel of their choice.

Whilst we are here concerned principally with heavy fuel oil it may be mentioned incidentally that heavy oil cannot be considered entirely apart from the lighter products, for the reason that the crude oil must necessarily be relieved of some of its lighter fractions in order to obtain the desired safety of flash point in the heavy fuel; and also because the lighter fractions are in great demand.

At the Spring meeting of the American Petroleum Institute, held at Washington, Mr. Walter C. Teagle, President of the Standard Oil Company, New Jersey, estimated the world's requirements of petroleum in 1922, at 100,000,000 tons, of which the United States would require about 81,500,000 tons. He put the consumption per head per annum in the United States, at 200 gallons against 14 gallons for the rest of the world. The British consumption *per capita* has been reported elsewhere to be about $\frac{1}{6}$th of that in the United States.

As regards the world's potential crude oil resources, the minds of many experts and others have been busy. Quite recently the American Association of Geologists has decided to co-operate with the United States Geological Survey in estimating the petroleum resources of that country, and a Co-operation Committee has been formed (June, 1921). As far back as 1886, Professor J. P. Leslie (quoted by Sir Boverton Redwood and other writers) said: "I am no geologist if it be true that the manufacture of oil in the Laboratory of Nature is still going on at a hundredth or the thousandth part of its exhaustion."

One of the best known recent estimates of an oil geologist is that of Dr. White, on the basis of figures prepared by Mr. Eugene Steburger of

the United States Geological Survey. He assumes the world's potential supply of crude oil still underground to be about 43,000,000,000 barrels, the equivalent in tons being roughly 5,927,000,000. At the present annual rate of consumption, this supply would last for between fifty and sixty years. Dr. White divides the estimated underground supplies fairly equally between the Eastern and Western Hemispheres. Other American oil geologists have expressed somewhat similar opinions as to the world's probable aggregate supplies. Estimates of this nature are apparently based, as a rule, not on the total quantity of crude oil that may be beneath the surface but on the total that may be brought to the surface in the usual way by natural gas pressure and by pumping. It is stated by experts that neither gas pressure nor pumping, as a rule, exhausts more than a proportion, in some cases relatively small, of the oil in the sands, and much attention is being given to methods of draining the oil deposits more completely. It is obvious also, that it is difficult for the geologists to make full allowance for improvements in drilling methods which may enable oil to be produced from much lower levels than at present. Whilst the best estimates must necessarily be those of the oil geologists, the opinion of practical oil men and experience of past production, suggest that the geologists' estimates are naturally of a conservative nature. Few, if any, oil geologists could, or would, have predicted with accuracy the output of some of the world's exceptional wells in the United States, in Mexico and elsewhere. Nor can the world's geology be said to be so well ascertained or the quantities of oil derivable from particular strata to be so finally and definitely determined for all parts of the world, that expectation in the aggregate may not be placed on a somewhat more optimistic level than the prudent and conservative oil geologist would consider safe.

### The Search for Oil.

It is public knowledge that the search for oil is being actively carried on in all parts of the world where geologists consider that there is any prospect of success. Experts would probably differ in their estimates of quantities and qualities likely to be found in particular localities, even where the drill has proved the presence of oil, but hopefulness in regard to prospects for the world's supplies as a whole is permissible for the reasons stated and the increasing efficiency of geological and engineering methods. The search for oil to-day is very active in all parts of the American Continent from the Mackenzie River in the North of Canada to the South of Argentina. Europe is being searched in new directions as well as in the neighbourhood of the proved fields. Asia has great potentialities, and Dr. White places a considerable part of the world's potential supplies in that continent, already a great producer, including its islands. Asia is likely to receive increased attention when political conditions, in certain regions, are more normal. Australasia is being investigated. Sections of Africa outside of the producing areas of Egypt are also under examination. Russia and Roumania are

generally expected to advance beyond their former production as political, transport, and exchange conditions improve.

In respect to the great possibilities of America and American oil enterprise, it was stated, in the Foreign Office despatch already quoted, that—

> The United States has, through her unique natural resources, been able to develop a vast industry with great organisations, whose experience, wealth and energy make it certain that her present overwhelming lead in oil production will be retained for many generations to come. Apart from her home deposits (of which fresh discoveries continue to throw doubt on pessimistic forecasts of early exhaustion), the United States is already taking the chief share in the development of the Mexican oilfields, and is certain to play a leading part in opening up those of Central and South America, as well as of other countries.
>
> It is becoming increasingly obvious, however, that there is ample scope for the activity and enterprise of all nations in searching for and bringing into use the world's stores of petroleum as yet undiscovered.

Mr. G. O. Smith, Director of the United States Geological Survey, speaking at Washington a few months ago and commenting on the White-Steburger estimate, said that the continents in order of oil wealth are North America, Asia, South America, Europe, Oceania, and Africa. The largest unexplored areas are in South America, Africa, and Oceania. More than half the world's oil reserves are believed to be concentrated in two inter-continental areas, one bordering the Caribbean Sea and the other the Caspian. Mr. G. O. Smith also pointed to the economy of sea transportation of oil to be expected in the future when the Eastern and Western Hemispheres are in a position more nearly to meet their own requirements without expending oil largely to convey oil from West to East.

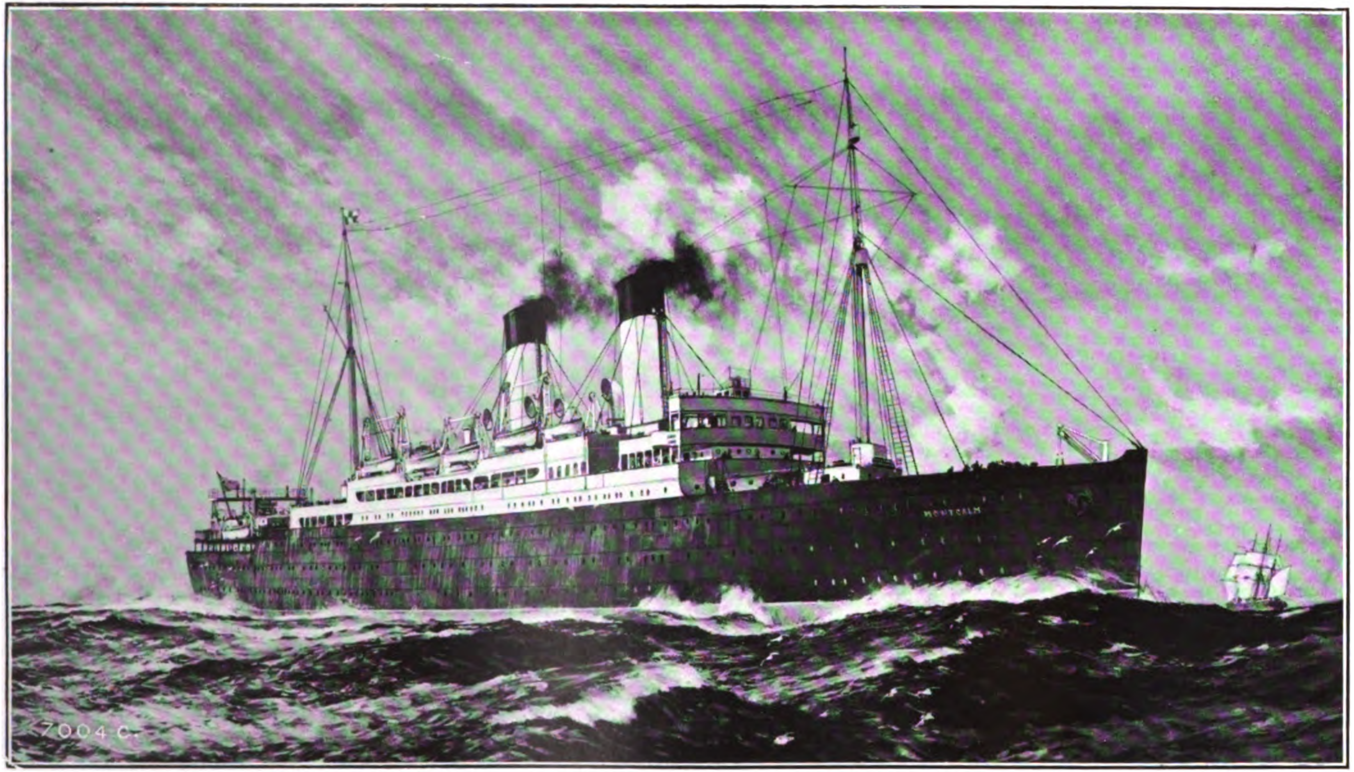
Beyond the primary supplies of natural petroleum lie the secondary sources from shale, coal and other bituminous materials. A former Secretary of the United States stated that distillation of shale deposits in Colorado, Utah and Wyoming might produce 70,000,000,000 barrels of oil, equivalent to about 10,000,000,000 tons, *i.e.* enough to keep the whole world supplied with oil, at the present rate of consumption, for 100 years; Canada and many European countries (including the United Kingdom) and also Australia have large shale deposits.

## The Need for Economy.

On Dr. White's estimate, the world has used some 1200 million tons of natural petroleum, or one-sixth of its estimated resources, in the sixty years since petroleum oil has been worked in marketable quantities; and, at the present rate of consumption, may use the remaining five-sixths of its natural petroleum in the next sixty years. For reasons given, the period may probably be considerably extended. The more optimistic persons tell us that the world has only been "scratched" for oil at present, or that the earth's crust is but the shell of an egg of infinite richness in the means of producing heat and energy. No optimism, however, is an excuse for waste of an essential natural product. Many voices have been lifted up to this effect, not only from the scientists but equally from prominent men

interested in oil production. Rationing, substitutes, temporary reversions to coal, etc., will always aid in tiding over a crisis, but in the main, the world must rely upon active enterprise to bring in new supplies of natural petroleum and the best and most scientific methods to ensure its economical production and distribution. Moreover, oil producers, engineers and consumers must co-operate to obtain the greatest efficiency from whatever supplies are made available.

FREDERICK W. BLACK.



TWIN-SCREW STEAMER MONTCALM, FOR THE CANADIAN-PACIFIC RAILWAY COMPANY.

Built and engined by Messrs. J. Brown & Co., Ltd., Clydebank.

## CHAPTER IX.

### STANDING OF THE WORLD'S MERCHANT FLEETS.

THE merchant shipping of the world has already recovered from the losses it sustained during the war, amounting altogether to upwards of 15,000,000 gross tons; on June 30, 1921, nearly 62,000,000 gross tons were afloat, while upwards of 6,000,000 gross tons were still in various stages of construction.

The sailing ship is rapidly disappearing, in spite of the attention which the United States devoted to construction in that material during the war. At the beginning of the century, 22 per cent. of the shipping of the world was still propelled by the wind acting on sails; in 1914 the percentage had fallen to 8 per cent; and by the middle of 1921 the proportion had further decreased to just over 5 per cent. On the other hand, 1,100 vessels are fitted with both sail and auxiliary engine power; of this total, 740 vessels are equipped with motors, and are, therefore, no longer to be regarded as belonging to the old order. The sailing ship has ceased to be of great importance in the international carrying trade, for time is money and the sailer moves slowly and uncertainly. The vessels built of wood are also of small account.

In assessing the carrying power of the shipping now afloat, Lloyd's Register of Shipping, in its new Register Book, regards only steel and iron sea-going vessels as possessing value for statistical purposes.

The following notes on the latest statistics prepared by Lloyd's Register, are of interest:—

Notwithstanding the increased construction and the large amount of ex-enemy tonnage allocated to British ownership, and, of course, included in the figures, there are at the present time only 411,000 tons more owned in the United Kingdom than in 1914.

The sea-going tonnage of the United States has increased by nearly 10½ million tons, an increase of 570 per cent. on the 1914 figures. The other countries in which the largest increases are recoroed are:—Japan (1,421,000); France (1,128,000 tons); Italy (950,000 tons); and Holland (736,000 tons). As in the case of the United Kingdom, the figures for France and Italy include a considerable amount of ex-enemy tonnage allocated to these countries.

The figures for Germany conclusively show the change in the maritime position of that country. While in 1914 Germany ranked next to the United Kingdom with over 5,000,000 tons of sea-going steel and iron steamers, her total tonnage now stands at only 654,000 tons.

The United States percentage of the world's sea-going steel and iron steam tonnage has increased from 4·3 in 1914 to 22·7 in 1921.

The relative position of some other countries has also altered to a large extent. In 1914 the United Kingdom owned nearly 44½ per cent. of the world's sea-going steam tonnage. the present percentage is just over 35½.

Taken together, the Scandinavian countries—Norway, Sweden, and Denmark—show an increase, as compared with 1914, of 505,000 tons.

Summarising the totals it will be seen that the present position of the sea-going merchant steel and iron steam tonnage as compared with 1914, is as follows:—

| | | |
|---|---|---|
| Increase in the United Kingdom . . . . | 411,000 | tons |
| Increase in the United States . . . . . | 10,477,000 | " |
| Increase in other countries . . . . . . | 6,311,000 | " |
| Total . | 17,199,000 | " |
| Loss to Germany . . . . . . . . . . | 4,444,000 | " |
| Ex-Austro-Hungarian Tonnage . . . . . | 1,052,000 | " |
| Total . | 5,496,000 | " |
| Net World's Increase . | 11,703,000 | " |

Lloyd's Register Book records that, in 1914, there were 3,668 sea-going steamers each of 4,000 tons and above; there are now 5,209. The greatest increase has taken place in those of between 6,000 and 10,000 tons, their number having increased from 1,004 in 1914 to 1,784 in 1921 as shown in the following table:—

SEA-GOING STEAM AND MOTOR VESSELS OF 4,000 TONS AND ABOVE.

| Flag. | | 4,000 and under 6,000 | 6,000 and under 10,000 | 10,000 and under 15,000 | 15,000 and above. | Total. |
|---|---|---|---|---|---|---|
| British . . . . | 1914 | 1,283 | 462 | 111 | 27 | 1,883 |
| | 1921 | 1,299 | 705 | 135 | 47 | 2,186 |
| United States . . | 1914 | 82 | 50 | 10 | 1 | 143 |
| | 1921 | 770 | 609 | 56 | 14 | 1,449 |
| Dutch . . . . | 1914 | 62 | 42 | 5 | 3 | 112 |
| | 1921 | 84 | 100 | 6 | 4 | 194 |
| French . . . . | 1914 | 103 | 52 | 12 | 2 | 169 |
| | 1921 | 161 | 88 | 17 | 3 | 269 |
| Italian . . . . | 1914 | 80 | 27 | — | — | 107 |
| | 1921 | 184 | 66 | 6 | 4 | 260 |
| Japanese . . . . | 1914 | 61 | 43 | 7 | — | 111 |
| | 1921 | 183 | 85 | 8 | — | 276 |
| Norwegian . . . | 1914 | 58 | 12 | 2 | — | 72 |
| | 1921 | 109 | 35 | 2 | — | 146 |
| Others * . . . . | 1914 | 703 | 316 | 31 | 21 | 1,071 |
| | 1921 | 322 | 96 | 9 | 2 | 429 |
| Grand Total . . . | 1914 | 2,432 | 1,004 | 178 | 54 | 3,668 |
| | 1921 | 3,112 | 1,784 | 239 | 74 | 5,209 |

Whereas in 1914 there were in existence 385 steamers for the carriage of petroleum in bulk with a tonnage of 1,479,000 tons, the present Register Book includes 861 steam and motor vessels of 4,419,000 tons for that trade, an increase of 200 per cent. in the tonnage. If the smaller vessels were excluded, say those of under 2,000 tons, which are mostly used for local trade, the average of the other 731 would reach 5,875 tons each. Included in the total, are 55 vessels of between 8,000 and 10,000 tons, and 37 of over 10,000 tons each.

The number of vessels fitted with internal-combustion engines has increased enormously since 1914. At that date 290 such vessels of 234,000 tons were recorded in the Register Book, and now the total figures are 1,447 of 1,263,000 tons.

A great development has also taken place as regards the use of liquid fuel on board steamers. In 1914 there were 364 steamers of 1,310,000 tons fitted for burning oil fuel, whereas the present Register Book includes no less than 2,536 such vessels of 12,797,000 tons, which tonnage is more than 9 times larger than that of 1914.

* Among "others" are included German vessels, and a number of ex-German vessels not yet allocated to Allied countries.

The following interesting comparison between the two years may be noted as regards the division of motive power.

| | 1914 % of total gross tonnage. | 1921 % of total gross tonnage. |
|---|---|---|
| Sail power only . . . . . . . . . | 7·95 | 5·05 |
| Oil, etc., in internal combustion engines . | 0·47 | 2·0 |
| Oil fuel for boilers . . . . . . . . | 2·62 | 20·65 |
| Coal . . . . . . . . . . . . . . | 88·96 | 72·30 |
| | 100·00 | 100·00 |

It will thus be seen that only 72 per cent. of the tonnage of the Merchant Marine now requires coal, while in 1914 the percentage was 89.

The relative position of the principal ship-owning nations is reflected in the following table, the figures for June, 1921, being contrasted with those of the corresponding month of 1914:—

STEAM TONNAGE OWNED BY VARIOUS NATIONS (MILLIONS OF TONS).

| June, 1914. | | June, 1921. | |
|---|---|---|---|
| 1 {United Kingdom | 18·89 | 1 {United Kingdom | 19·29 |
| British Empire | 20·52 | British Empire | 21·34 |
| 2 Germany | 5·13 | 2 U.S.A. (sea-going) | 12·31 |
| 3 U.S.A. (sea-going) | 2·03 | 3 Japan | 3·06 |
| 4 Norway | 1·96 | 4 France | 3·05 |
| 5 France | 1·92 | 5 Italy | 2·38 |
| 6 Japan | 1·71 | 6 Norway | 2·28 |
| 7 Holland | 1·47 | 7 Holland | 2·21 |
| 8 Italy | 1·43 | 8 Spain | 1·09 |
| 9 Austria-Hungary | 1·05 | 9 Sweden | 1·04 |
| 10 Sweden | 1·01 | 10 Denmark | 0·86 |
| 11 Spain | 0·88 | 11 Germany | 0·65 |
| 12 Greece | 0·82 | 12 Greece | 0·57 |
| 13 Denmark | 0·77 | 13 Brazil | 0·47 |

The fall in freights, which began in 1920, occurred too late to arrest the construction of any considerable number of ships, though in this country work was suspended on as much as one-third of all the tonnage under construction, owing to the joiners' strike, the coal dispute, and the high level at which wages and cost of production generally stood. In spite of this movement to delay completion, which was more marked in British than in foreign yards, vessels of 100 tons gross and upwards, as shown in the table on page 302, were in hand on June 30, 1921. Another table on that page shows the sizes of the vessels building.

The tonnage under construction in the United Kingdom on June 30, 1921, was about 268,000 tons less than that which was in hand at the end of the previous quarter, and about 48,000 tons less than the tonnage building a year previous.

These figures, as has been said, do not represent the work actually in progress. The total returned as under construction includes 735,000 tons on which work had been suspended. It also includes 444,000 tons the completion of which had been postponed, owing principally to the joiners' strike and the coal dispute. If these two totals, amounting to 1,179,000 tons, be deducted from the tonnage under construction, for the purpose of comparison with normal figures, the effective figure is reduced to 2,351,047 tons.

Two hundred and two vessels were under construction for foreign

MERCHANT VESSELS UNDER CONSTRUCTION IN THE UNITED KINGDOM.

| Description. | June 30, 1921. | | March 31, 1921. | | June 30, 1920. | |
|---|---|---|---|---|---|---|
| | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. |
| STEAM. | | | | | | |
| Steel | 711 | 3,282,738 | 790 | 3,528,190 | 895 | 3,565,910 |
| Ferro-Concrete | — | — | — | — | | |
| Wood and Composite | 4 | 2,174 | 4 | 2,174 | | |
| Total | 715 | 3,284,912 | 794 | 3,530,364 | | |
| MOTOR. | | | | | | |
| Steel | 54 | 240,198 | 60 | 260,731 | | |
| Ferro-Concrete | 2 | 600 | 4 | 2,094 | | |
| Wood and Composite | 1 | 205 | 2 | 355 | | |
| Total | 57 | 241,003 | 66 | 263,180 | | |
| SAIL. | | | | | | |
| Steel | 16 | 3,832 | 23 | 4,749 | 46 | 12,243 |
| Ferro-Concrete | — | — | — | — | | |
| Wood and Composite | 1 | 300 | 1 | 300 | | |
| Total | 17 | 4,132 | 24 | 5,049 | | |
| Total Steam, Motor, & Sail | 789 | 3,530,047 | 884 | 3,798,593 | 941 | 3,578,153 |

or Dominion owners, including Argentine, 7; British Dominions, 24; Belgium, 5; Chili, 4; Denmark, 8; France, 49; Greece, 3: Holland, 22; Italy, 4; Japan, 4; Norway, 55; Roumania, 1; Spain, 12; Sweden, 1; United States, 3. The total tonnage was 978,752.

SIZE OF VESSELS UNDER CONSTRUCTION IN THE UNITED KINGDOM ON JUNE 30, 1921.

| Gross Tonnage. | Number. | | |
|---|---|---|---|
| | Steam. | Motor. | Sail. |
| * 100 and under 500 tons | 88 | 17 | 17 |
| 500 " 1,000 " | 92 | — | — |
| 1,000 " 2,000 " | 77 | 6 | — |
| 2,000 " 3,000 " | 55 | 1 | — |
| 3,000 " 4,000 " | 62 | 3 | — |
| 4,000 " 5,000 " | 42 | 2 | — |
| 5,000 " 6,000 " | 80 | 4 | — |
| 6,000 " 8,000 " | 108 | 16 | — |
| 8,000 " 10,000 " | 48 | 8 | — |
| 10,000 " 12,000 " | 6 | — | — |
| 12,000 " 15,000 " | 27 | — | — |
| 15,000 " 20,000 " | 24 | — | — |
| 20,000 " 25,000 " | 5 | — | — |
| 25,000 " 30,000 " | 1 | — | — |
| 30,000 " 40,000 " | — | — | — |
| 40,000 tons and above | — | — | — |
| Total | 715 | 57 | 17 |

In spite of the slowing up of construction in the United States, foreign yards were still busy on new work on June 30, 1921. Eight hundred and fifty-one vessels, aggregating 2,669,421 tons, were then in hand abroad, so that, in the world's shipbuilding establishments, no fewer than 1,640 ships, making 6,199,468 tons together, were being built. Particulars are given in the following table:

MERCHANT VESSELS UNDER CONSTRUCTION ABROAD JUNE 30, 1921.

| Countries. | Steamers. | | | | Motor Vessels. | | | | Sailing Vessels. | | | | Total. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Steel. | | Wood. | | Steel. | | Wood. | | Steel. | | Wood. | | No. | Gross Tonnage. |
| | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | | |
| America :— | | | | | | | | | | | | | | |
| United States: Atlantic Coast | 58 | 469,364 | — | — | 4 | 24,039 | — | — | 2 | 1,600 | 2 | 5,600 | | |
| United States: Gulf Ports | 10 | 44,741 | — | — | — | — | — | — | — | — | — | — | | |
| United States: Pacific Coast | 22 | 164,200 | — | — | 1 | 3,800 | 1 | 2,200 | — | — | — | — | 102 | 717,624 |
| United States: Great Lakes | — | — | — | — | 2 | 2,080 | — | — | — | — | — | — | | |
| British Dominions: Canada :— | | | | | | | | | | | | | | |
| Great Lakes | 2 | 4,803 | — | — | — | — | — | — | — | — | — | — | | |
| Coast | 23 | 81,870 | 1 | 140 | 1 | 350 | — | — | — | — | 6 | 6,960 | | |
| Australia | 8 | 26,659 | 1 | 140 | — | — | — | — | — | — | 2 | 3,580 | 62 | 177,912 |
| Hong Kong | 11 | 49,500 | — | — | 1 | 150 | — | — | 2 | 910 | — | — | | |
| Others | 2 | 2,500 | 1 | 200 | — | — | — | — | — | — | 1 | 150 | | |
| Belgium | 7 | 23,165 | — | — | — | — | — | — | — | — | — | — | 7 | 23,165 |
| Brazil | 1 | 2,170 | — | — | — | — | — | — | — | — | — | — | 1 | 2,170 |
| China | 7 | 24,698 | — | — | — | — | — | — | — | — | — | — | 7 | 24,698 |
| Denmark | 26 | 45,700 | — | — | 16 | 63,260 | 1 | 450 | — | — | — | — | 43 | 109,410 |
| Esthonia | — | — | — | — | 3 | 1,200 | 2 | 405 | — | — | 14 | 3,585 | 19 | 5,190 |
| Finland | 7 | 5,819 | — | — | — | — | 4 | 1,305 | — | — | 3 | 980 | 14 | 8,104 |
| France | 92 | 374,178 | — | — | 2 | 8,400 | — | — | 8 | 7,285 | 3 | 590 | 105 | 390,453 |
| Greece | 1 | 900 | — | — | — | — | 1 | 600 | — | — | — | — | 2 | 1,500 |
| Holland | 137 | 371,684 | — | — | 11 | 17,505 | — | — | 7 | 2,200 | — | — | 155 | 391,389 |
| Italy | 51 | 250,629 | 5 | 2,470 | 8 | 37,706 | 32 | 10,740 | — | — | 32 | 8,788 | 128 | 310,333 |
| Japan | 45 | 229,262 | — | — | — | — | — | — | — | — | — | — | 45 | 229,262 |
| Norway | 45 | 63,923 | — | — | 5 | 19,490 | 7 | 1,486 | 2 | 475 | — | — | 59 | 85,374 |
| Portugal | — | — | 4 | 1,523 | — | — | 6 | 4,700 | — | — | 30 | 9,000 | 40 | 15,223 |
| Spain | 17 | 79,917 | — | — | — | — | — | — | — | — | 1 | 150 | 18 | 80,067 |
| Sweden | 19 | 33,536 | — | — | 16 | 61,095 | 2 | 980 | 1 | 661 | 6 | 1,275 | 44 | 97,547 |
| Total | 591 | 2,349,218 (a) | 12 | 4,473 | 70 | 239,075 (b) | 56 | 22,866 | 22 | 13,131 (c) | 100 | 40,658 | 851 (d) | 2,669,421 |

(a) Including 1 ferro-concrete vessel of 475 tons. (b) Including 1 ferro-concrete vessel of 2,000 tons. (c) Including 5 ferro-concrete vessels of 5,000 tons. (d) At the end of June there were under construction abroad 79 steamers and motor vessels of 1,000 tons and above, with a total tonnage of 565,598 tons, intended to carry oil in bulk. Of these vessels 48, of 388,868 tons, were building in the United States of America, and 8 of 58,980 tons in France.

As Sir Owen Philipps, the President of the Chamber of Shipping, pointed out in his initial address, there are roughly six vessels now to do the work of every five ships before the war, and as the total

quantity of the carrying trade in the world, reckoned in tonnage, has not yet resumed even the pre-war level, it was not surprising that there were more vessels afloat than use could be found for. On the other hand, he directed attention to the large amount of old tonnage still afloat. Reviewing the shipping situation generally, he declared that he was an optimist.

"In my commercial life I have been through several periods of bad times when British steamers have been laid up in hundreds. I know from experience that nothing is more calculated to teach a shipowner efficiency and economy in working his vessels than a few years of really hard times, when the uneconomic ships of a fleet have to be sold to the shipbreaker, organisations overhauled, and businesses have to be run on the rock-bottom basis. Depression in shipping is different from that in any other trade or manufacture, because the life of a ship is very limited. Although, in certain trades, some vessels may continue to do economic work for long periods, the normal life of a vessel is only about twenty years, and therefore five per cent. of the total tonnage of the world, or, say over three million tons of world shipping, ought in the natural course of events to be broken up every year."

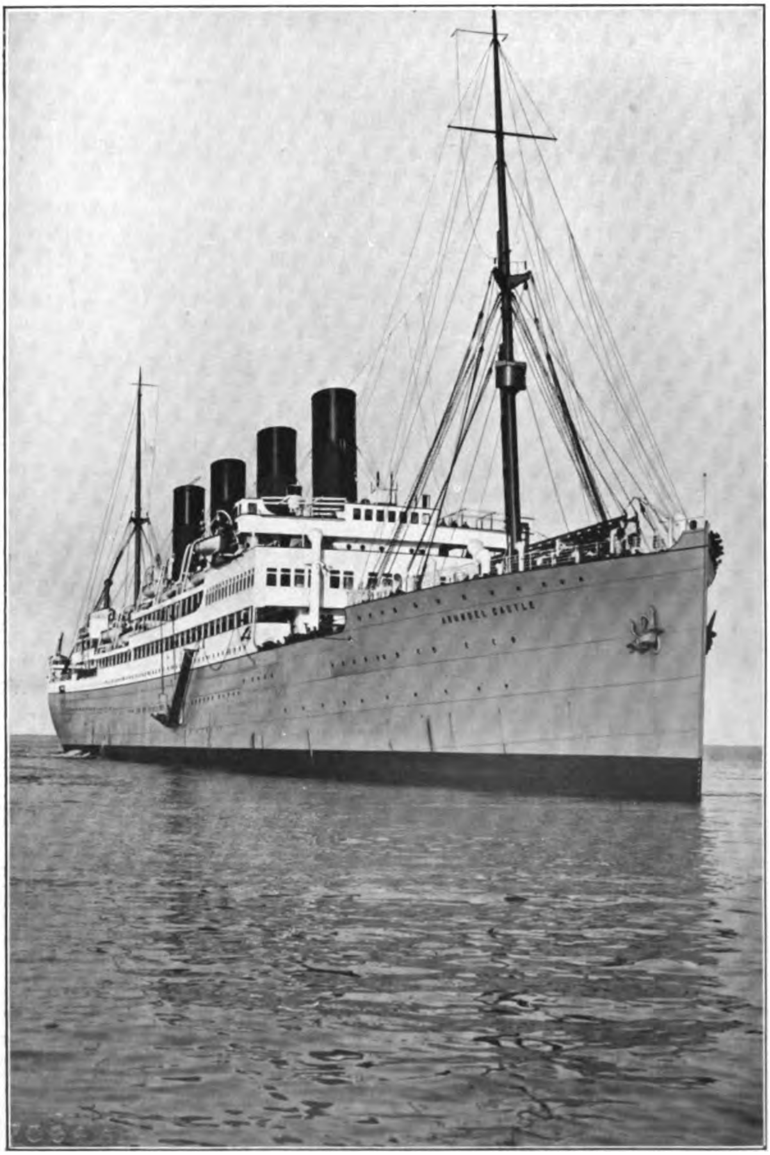
This process of elimination was almost completely arrested during the war, with the result that, as Sir Westcott Abell remarks in an article in this "Annual," there is still a good deal of old tonnage afloat which, in normal circumstances, would have been scrapped. Some 5,757,000 gross tons of the world's shipping are over 25 years old, and of this tonnage, vessels of only 1,701,000 tons are under the British flag. Now that trade is restricted and freights have fallen, this process of removal from the effective lists will undoubtedly be revived.

As Sir Frederick Lewis has pointed out—

If, for the purposes of estimating the effective world tonnage, these are disregarded, we arrive at an increase of 5,945,825 gross tons over 1914. Of this increase, however, 2,940,000 gross tons is represented by the increase in bulk oil carriers, and whilst, to some extent, these may displace coal carrying, for ordinary general purposes of the world's trade it may be said there are, in effect, only 3,005,825 gross tons more of serviceable vessels afloat to-day than there were in 1914. Notwithstanding these figures, there is laid up in the world's ports an amount of tonnage which was recently estimated at round about 10,000,000 tons.

The optimistic opinions of the President of the Chamber of Shipping may be accepted as reflecting the views of British shipowners generally. In spite of temporary adversity due to restricted employment and lower freights, with a consequent laying up of a large volume of tonnage, they are by no means downhearted, though they realise that some time may elapse before healthy conditions in the shipping industry again exist.

THE EDITORS.



UNION CASTLE ROYAL MAIL STEAMER ARUNDEL CASTLE.
Built and engined by Messrs. Harland & Wolff, Ltd., Belfast.

## CHAPTER X.

### The State and Merchant Shipping.

In November, 1918, when actual fighting in the late war came to an end, nine-tenths of the sea-going merchant tonnage of the world was under the control of the Governments allied in opposition to the Central European Powers. Many ships were not only controlled but owned by the allied Governments. Most of the shipbuilding undertaken to make good losses caused by submarines had been on Government account. Thus it came about that, on the resumption of ordinary trading by sea, the conditions differed from those of pre-war days in that a large number of merchant ships were State owned. Several of the late belligerent States engaged in business as shipowners, that is, they did not limit themselves to ownership, but proceeded to operate their ships commercially. They entered the field of international trade in competition with ordinary shipowners, and they are continuing their trading. It is proposed here to present some facts and considerations in relation to this new development which was one of the results of the war.

The United States of America, Australia, Canada, and France are the countries whose Governments have put into practice a policy of State ownership and operation of merchant shipping. The British Government followed the opposite course of selling its ships. As rapidly as possible they were transferred to private ownership, and, though some still remain in the hands of the Government, they are a mere remnant, and the process of reduction is being completed as quickly as possible. At the beginning of July, 1921, there were 130 vessels owned by, or under the direct control of, the Government, exclusive of oilers and colliers owned by the Admiralty and used for naval purposes. The policy of this country has been officially and unequivocally declared and carried out in a way which places British merchant ships outside the scope of these notes. The policy of the United States also, it is true, contemplates that ultimately all ships will be transferred to private owners, but, as will be seen, that consummation is admittedly some years distant, and, in the interval, the United States Government is actively trading.

It will be convenient, in the first place, to trace briefly the steps by which the various Governments entered upon the ownership of merchant fleets.

### The United States Merchant Fleet.

The United States Shipping Board was created by an Act of September, 1916, before America had entered the war. The measure

was intended to promote the development of the American merchant marine, but it was not the intention of Congress that the Shipping Board should operate ships. Its original powers were chiefly regulatory, but, before it had had time fully to take up its duties, the whole position was changed by the entry of the United States into the war in April, 1917. Thereupon further legislation, which was at once passed, conferred upon the President authority to requisition, construct and operate shipping, which authority he delegated to the Shipping Board, and (so far as shipbuilding was concerned) to the Emergency Fleet Corporation, which had already been constituted under the Act of 1916.

"The Shipping Board was transformed overnight, as it were" (wrote Mr. E. N. Hurley in "The New Merchant Marine"), "into an agency, first for the acquisition of vessels, and second for their operation." The full story of how America carried out her enormous programme of ship construction may be read in the work referred to by Mr. Hurley, who was Chairman of the Shipping Board, or in the account of "American Shipbuilding during the War," by Sir Westcott Abell in last year's issue of this "Annual." When America declared war, the greater number of the 234 berths in the country were occupied by vessels building for the Navy. The remainder were engaged in the construction of ships for private owners, some American, but mostly of other nationalities. In August, 1917, the United States commandeered all hulls and ship materials in American shipyards intended for the building of vessels of 2,500 tons deadweight or more. Thereafter building was on Government account. At the date of the Armistice, America had "a total of 1099 ways, more than three times the number of berths in the rest of the world, of which approximately 40 per cent. were for the building of steel ships, and the remainder for wood and concrete vessels, tugs, and barges" (Hurley, page 37).

Not only did the American Government build ships in numerous yards, including Hog Island, Philadelphia, where "fabricated" ships were turned out, but took over 600,000 tons of interned German ships, acquired, for the time being, all the neutral tonnage available, and arranged for the building of ships in Japan and China. Later, the United States acquired a share of the German ships surrendered under the Armistice arrangements.

Thus the war left in American hands a merchant fleet, mostly built in the emergency of war circumstances and primarily for war purposes, consisting of over 2,300 vessels, aggregating 13,600,000 deadweight tons; they were mostly cargo carriers, and mostly steel ships, but included nearly 600 wooden vessels.

### The Australian and Canadian Experiments.

In June, 1916—in which month the Battle of Jutland was fought, while the submarine campaign was being prosecuted with a heavy loss of British and Allied merchant tonnage—Mr. W. M. Hughes, Australian Prime Minister, endeavoured to obtain from the British

Government increased facilities for shipping Australian produce which had accumulated in the country of its origin since the war had disorganised shipping services. Having failed in his endeavour, Mr. Hughes arranged for the State purchase of fifteen cargo steamers for about £2,000,000. That was the beginning of the Commonwealth Government Line of steamers. These steamers carried cargo during the war and were exempt from the control of freights and routes, to which British shipping was subjected. Two were sunk by enemy action, and two have since been sold, leaving eleven, which are still trading under State management.

Additions to the Australian Government merchant fleet comprise 5 wooden steamers built in America in 1918, 17 ex-enemy steel steamers, the majority of which are over 7,000 tons deadweight, and 6 steamers, each of 5,600 tons deadweight, built in 1919–20. In addition, there is a building programme, in pursuance of which a number of ships are under construction. In Australia, 14 steamers, each of 6,000 tons deadweight, and 4 larger vessels, each of 12,700 tons deadweight, are to be built. Some of the smaller class are already completed and in use. There are also 5 passenger and cargo steamers of 15,000 tons deadweight all being built in this country, 3 at Barrow and 2 on the Clyde. Two of these have been launched, but they are not yet completed.

Tasmania, it is interesting to note, decided in 1919 to experiment with State shipping, but so far only three steamers have been acquired.

A programme of Government merchant shipbuilding was decided upon in Canada early in 1918, as a war measure. To assist in making good the loss of tonnage caused by German submarines, Canadian yards had already been building steel ships for the British Government. These ships necessarily came under British control when ready for use. The Canadian Government decided to build instead under Canadian registry for the Canadian people. The Government, already owning a railway system, deemed it necessary to complete the chain of transportation by providing ships to enable Canada to expand her export trade. No new contracts have been let since 1919, and the building programme is almost complete. It comprises 63 ships of an aggregate deadweight tonnage of 374,254, including 2 of 10,500 tons each, and a number of smaller vessels. The first of the two largest ships, launched at Halifax in July, 1921, was expected to be in commission in September, and it is anticipated that all the ships will have been built by the end of 1921.

So far as France is concerned, it may be added that in 1917 a credit was voted for the purchase and building of ships, and altogether some 700,000 tons deadweight were acquired as a State merchant fleet, including 340,900 tons of steel ships, 274,000 tons of wooden ships, and 77,700 tons of lighters. The wooden ships, and some of the others, were built in America. About 400,000 tons of ex-German vessels, mostly cargo boats, were assigned to France by the Reparations Commission.

## Position and Prospects of State Shipping.

In considering the position and prospects of State-owned merchant ships, or indeed of any trading vessels, the total capacity of shipping afloat in relation to the total trade to be done is a factor of first importance, for the trade of sea carrier is, more than any other occupation, an international business in which world conditions must be taken into account. The position, in this respect, is that the total tonnage of ships is greater than before the war, and the business to be done is less. "There are," said Sir Owen Philipps, President of the Chamber of Shipping of the United Kingdom, in his address at the annual meeting in February, 1921, "over sixty million tons of world shipping afloat, compared with under fifty million tons prior to the war. In other words, there are, roughly speaking, six vessels to-day to do the work of every five vessels before the war. As the total quantity of the trade of the world, reckoned in tonnage, has not yet resumed even the pre-war level, there are consequently more vessels afloat than the world is at present in need of." The same speaker, presiding at the annual meeting of the Royal Mail Steam Packet Company at the beginning of June, said: "The amount of tonnage of all nations which is at the present time lying idle in the ports of the world may, I think, be assumed to be not much less than 8,000,000 tons gross register, and probably more. All over the world the ports are full of vessels for which no employment is available." The actual total tonnage afloat, according to the latest edition of Lloyd's Register, is nearly sixty-two million gross tons, and a more recent estimate than Sir Owen Philipps' of the tonnage idle puts it at nearly one fourth of the total. In these circumstances it is not surprising that, in every instance, the recent experiment of State-owning and operating merchant ships has proved more or less of a failure.

## The Future of the United States Tonnage.

Before, however, making any attempt to indicate outstanding results, and the deductions to be drawn from them, it will be desirable to refer briefly to what has happened in each of the countries where the experiment of a State fleet of merchant ships has been tried.

The seagoing tonnage of the United States was, before the war, about 2 million tons gross. The present figure is about 12 million tons, and, of this, according to Mr. J. Parker Kirlin, an acknowledged authority, about 6 million tons—equivalent to about 10 million tons deadweight-carrying capacity in units of 5,000 tons or more—are serviceable for the foreign trade (*Lloyd's List*, Feb. 22, 1921).

The total Government fleet, as we have seen, is put at 13,600,000 tons deadweight by Mr. Hurley. The statement of Mr. Farrell, quoted presently, puts it at 16 million tons. Whatever the exact figure may be, the broad fact to note is that it was Government building which placed the United States in possession of the second largest merchant fleet in the world, a fleet exceeded in total capacity

only by that of the United Kingdom, and about four times as large as that of either Japan or France, which stand third and fourth.

It was considered by the United States Shipping Board that the sale of the great Government-owned fleet could not be completed in less than four or five years, so, in reporting to Congress in June, 1919, on the steps to be taken for the establishment of an adequate merchant marine under the American flag, the Shipping Board pointed out that, in the interim, it would be necessary for the Government to operate the unsold ships. Thus, though the Shipping Board recommended ultimate private ownership and operation, and Congress declared that to be its policy by the Merchant Marine Act, 1920, the conditions were, and are, such that for some years the American Government will remain in the shipping business. Indeed, the period which must elapse before the American Government can relinquish shipping business may prove to be longer than was calculated, because anticipations as to the sale of the emergency fleet have not been realised.

Speaking on the question of the future of the American Merchant Marine in May, 1921, Mr. James A. Farrell, President of the United States Steel Corporation, said: "The signing of the Armistice on Nov, 11, 1918, found us with a fleet of 16,000,000 deadweight tons, built and under contract, as the result of the dictates of military necessity. Efforts were made after the Armistice to induce the Shipping Board to sell a large portion of the fleet to foreigners. For a period extending into 1919, an opportunity existed to dispose of a large portion of the fleet at prices bearing a fair relation to a moderately depreciated cost. Not taking advantage of this opportunity, the Government 'missed its market,' and, it is estimated, lost a chance to realise at least 800,000,000 dols., being the difference in the market value of the tonnage of steel ships which could have been sold at that time and the appraised value to-day."

The American policy of selling at the current world market price all Government-owned steel vessels went astray in its practical application. Though a large amount of the tonnage could probably have been disposed of at reasonable prices, this was not what happened. "The unfortunate result of holding out for prices 100 per cent. above the market has been," as Mr. J. Parker Kirlin has pointed out, "that only a negligible quantity of the ships has been sold." According to official statistics, the Shipping Board, from its inception up to December, 1920, sold only 430 vessels, aggregating rather more than 2 million deadweight tons. Meanwhile the slump in trade made it impossible to retain in use a large proportion of the ships still owned by the Government. In May, 1921, the gradually increasing number of steel vessels withdrawn from operation had grown to over 700. These are considerably more than half the fleet, and the remainder are being run at a loss. The operations of the Shipping Board for the American fiscal year ended June 30, 1921, resulted in a loss of 200 million dollars, and there was then a continuing loss calculated at 16,000,000 dollars monthly.

Despite these facts, President Harding, in June, 1921, declared that the Shipping Board must dispose of its ships at right prices, and

not sacrifice them. He felt that this could not be accomplished in a short time and that the future must be built solidly on the development of private initiative and operation. This recognition of the importance of individual effort and enterprise may be regarded as the declaration of a new policy, as, in fact, an acknowledgment that State-owned and operated shipping has failed, and, if one may accept a report presented to the Congress of the International Chamber of Commerce in London in June, as correctly stating the present position, "there is general agreement in the belief that there never will be a successful merchant marine under the flag of the United States until the Government has ceased to operate ships and has disposed of its vessel property to private interests." The signatories to this report included Mr. P. A. S. Franklin, Mr. Matthew Hale, Mr. Frank Munson, and Mr. J. Parker Kirlin, and much importance must therefore be attached to it.

The problem, however, of carrying out the transfer to private ownership, or, in other words, of inducing American capital to invest in shipping, remains. It is beyond our scope to examine this in detail. It is sufficient to note that, in the opinion of competent observers, American legislative and industrial conditions are at present a serious deterrent. This being so, the American Government must apparently continue for some time its unremunerative sea trading enterprises, involving taxpayers in heavy calls. The United States Shipping Board itself is understood now to hold the view that Government control of the mercantile marine, while necessary during the war, is a tremendous mistake. Mr. Albert Lasker, who has recently become chairman of the Board, is reported to have stated that "America's shipping business to-day is the most colossal commercial wreck the world has ever seen, and the financial backing of the Government alone prevents it being the greatest bankruptcy ever recorded." Point after point of evidence comes to light showing that the bureaucrats have made a hopeless mess of things and have involved taxpayers in huge liabilities, present and prospective. In August practically all the fleet of wooden ships was sold at a nominal figure.

## The Experience of Australia and Canada.

Let us turn now to Australia's experiment. The Commonwealth Government Line has run a fortnightly cargo service between British and Australian ports, and, with the commissioning of the larger ships now being completed, a four-weekly 15-knot passenger and cargo service *via* Suez Canal is expected shortly to be in operation. No suggestion has been made that the monopoly of the previously existing lines has been exercised in a way detrimental to Australian interests, but apparently the risk that such adverse action might be taken is regarded as justifying the maintenance of the Government line. Its existence is alleged to have been a restraining influence which has prevented increases in freights. The policy of the Commonwealth Government, it is stated, is not to obtain a monopoly of shipping, if that were possible, but to foster and promote trade between Australia

and Great Britain. Apparently, however, commercial opinion in Australia is not altogether favourable now that a general fall in freights has followed the termination of the war and the abnormal conditions which immediately succeeded it. Indeed, it is being realised that any advantage from the operation of State ships would be reaped mainly by producers, while losses will fall on taxpayers as a whole, and that general trade stagnation and diminution of exports cannot be remedied by manipulating freights. In Australia, State shipping has made a profit in exceptional circumstances—since during the war the vessels were outside the "control" and were not run at "Blue-book rates"—and it was officially stated in July, 1921, that the Commonwealth Government Line was still operating at a substantial profit, but at the same time some of the steamers are admitted to be laid up owing to lack of payable cargoes, and this fact speaks for itself. Owing to the surplus of tonnage afloat in the world's seas, these State ships could now be sold only at a heavy loss, and Mr. Hughes—during his recent visit to England—denied that there was any intention to sell them.

Patriotic feeling, coupled with the prevalence of the idea that the Canadian Government shipbuilding scheme would be good for trade, made the early stages of that scheme easy, but, when the tide of fictitious prosperity which, all over the world, had flowed with inflated currency began to ebb, there were misgivings. Though, owing to the late period at which the programme was entered upon, no ship was actually launched till after the Armistice, it was decided in 1919 to continue the policy of shipbuilding. It proved impossible to complete all the ships in 1920. The necessary supply was duly voted that year to carry out the obligations entered into, but, when it came to a final vote in the spring of 1921, the misgivings, which the course of events had developed, had become so serious that it was with the greatest difficulty that the Canadian Government obtained sanction for the comparatively small sum then required to complete the work which had already been authorised. The item was not passed till the matter had been debated through an all-night sitting, adjourned, and the closure applied, when it came up again (Canadian Hansard, April 13, 1921).

The operation of the Government ships is entrusted to the Canadian Government Merchant Marine, Ltd., but the public are not thereby relieved of the burden of loss which the service entails. The ships, like the national railways, have to be kept going out of the taxpayers' pockets. When the question of a vote in supply to complete the building programme came up in the Dominion House of Commons, as already mentioned, the leader of the Opposition complained that the public have to meet the heavy taxation as regards railways, and will now have to pay also for the merchant marine (Canadian Hansard, March 29, 1921).

Various services have been established from Montreal to the West Indies and South America, the United Kingdom, the Mediterranean and the East, and from Vancouver to Australia and India, but it has been questioned whether these have been beneficial to Canadian trade. In the Parliamentary debate already referred to,

a member, who addressed the House for some five hours, said: "We have been told what these Government ships have been doing for our export business; but what do we find? All the ships have been doing practically is interfering with other companies already in existence." The same speaker also declared that "these ships do not carry Canadian cargo, but go to all parts of the world developing trade for the benefit of foreign countries" (Mr. Duff, Canadian Hansard, April 7, 1921).

In relation to these statements it should, perhaps, be mentioned that the ships of the Canadian Government Merchant Marine take their turn with those of the various companies in the list of sailings in connection with the Canadian National Railways, and, on these regular services, do not compete with other lines in rates of freight. Indeed, outside Canada, certain of the established companies act as agents in the business of the Government steamships, which therefore are on a different footing from those of the Australian Commonwealth Government Line.

The position in France, according to an official report recently published, is that the deficit in the management of the State fleet amounts to 500 million francs, and the probable loss by the liquidation of the fleet, which has been decided upon, is estimated at at least twice that figure.

The ships have been operated under direct management, but the result has shown the incapacity of the State to conduct a commercial undertaking. Regular services were established, but most of them have proved unremunerative. Privately owned shipping has had to contend, not only with severe foreign competition, but also with this State fleet, and the measure of loss is therefore greater even than that shown by the huge official deficit. In June, 1921, 92 of the Government-owned vessels had been laid up.

### The General Position.

We have seen that in America and France, State merchant shipping has proved a costly failure, while in Australia and Canada the indications are that the taxpayers will have to bear heavy losses. How long they will care to continue the experiment of Government trading, time will show. Meanwhile opinion in general throughout the world is unfavourable to the idea of State shipping.

At the last annual meeting of the Chamber of Shipping of the United Kingdom, in February, 1921, a resolution was passed placing on record the Chamber's recognition of the success of the steps taken in furtherance of the British Government's policy of restoring the complete freedom of the mercantile marine and its conviction that the best interests of the communities of the world will be served only by leaving shipping entirely to private enterprise and by opening and keeping open all ports of the world to international shipping without discrimination.

The shipowners' organisation, it may be said, is naturally in favour of a clear field for its members, but it is not only shipowners who have passed resolutions of this tenor. The Directors of the

International Chamber of Commerce, at a meeting in Paris in October, 1920, adopted a resolution expressing the view that direct construction, or direct operation, of commercial vessels by any Government is undesirable, and that a merchant marine constructed and operated under private initiative results in lower costs and more effective service, and therefore recommending that all Governments should entirely abstain from operating any commercial vessel except for their own purposes.

On the other hand, the advocates of Government management of commercial shipping are not without arguments. They urge that possibly by that means routes which would not otherwise have been opened up may be developed, or competition may be brought to bear so as to prevent a monopoly being used oppressively, but to quote these arguments is to damn with faint praise. If the field is free and open, monopoly does not continue to thrive, and, as for initiative, the long record of humanity does not suggest that collective movement is likely often to outdo the vigour of individual action.

If Governments are to interfere at all, the method of granting subsidies is perhaps less open to objection than direct trading. At the time of writing, the Italian Government was considering the grant of subsidies, and had introduced a Bill for the purpose of subsidising the national mercantile marine and fostering national shipbuilding. Many countries have tried shipping subsidies, but not with satisfactory results. Shipowners find the conditions necessarily attached to a grant hampering, and indeed, even in cases where subsidies have been popularly supposed to have assisted the development of shipping and trade, as in the case of Germany before the war, the opinion of those competent to judge was that the subsidies were minor factors in results which were due mainly to commercial skill and industry. This, however, is a digression. In summing up on the question of State ownership and operation of merchant shipping, it remains to point out that there are very definite objections to that system. The Government, as recent experience has shown, may compete with and injure its own nationals who are private shipowners. This difficulty will remain unless the States take over all shipping. But, if any industries are to be nationalised, shipping should be the last. Shipowning and managing is an occupation for specialists, for men who have learned by experience, who have acquired a business instinct enabling them to deal promptly and effectively with fluctuating and ever changing conditions, but who cannot provide a dry theory which will enable bureaucrats to do the work instead. Shipping business is, morover, international, and trouble between ships of different nationalities, when one or both is a Government ship, may bring in the war makers, where, had private owners only been concerned, the difference would have been settled without becoming a public question. Even in regard to ordinary questions of trade policy, a Government is apt to act in a narrow national way, and to forget that, in an international business, this will not do. Statesmen, as trustees for their fellow countrymen, almost inevitably pursue a nationally selfish policy, but trade, whether local or international, is always a mutual affair. It is not

carried on at all unless both sides think they will benefit. The function of mercantile shipping is not to assist trading communities of particular countries to "reach out aggressively for foreign markets"—the phrase is that of Mr. Ballantyne, Canadian Minister of Marine—but to provide facilities for interchange of commodities among nations, and that function is not best discharged, that purpose is not well served by State merchant shipping.

SANFORD D. COLE.

## CHAPTER XI.

### Standard Ships and Ex enemy Tonnage: Lord Inchcape's Sales.

Two thousand four hundred and seventy-nine British merchant vessels were destroyed through enemy action during the war by submarines, cruisers, torpedo boats, mines, or aircraft. The gross tonnage of these vessels was 7,759,090, and their sinking by the enemy involved the death of 14,287 persons, mostly British seamen, officers, or shipmasters. In addition, 1,885 British merchant vessels were molested but not sunk, but in these attacks a further loss occurred of 592 lives.

In the reckoning which Germany had to face at Versailles, these British losses, and losses from similar causes by allied nations, claimed and received consideration, and the matter was one of those reserved for final adjudication at the hands of the International Reparations Commission. Mr. Lloyd George had advocated, at the Peace Conference, that Germany should in the Reparations Account be credited only with the values at which the ships would eventually be sold and not at the inflated figures of value, then current, which had been produced by her wholesale destruction of shipping, chiefly by submarine attack. The German Government (July, 1921) eventually agreed that the estimate of their value originally submitted to the Reparations Commission was too high. The Prime Minister had meantime announced that the proceeds would be applied, first, to the cost of the British army of occupation, and, secondly, to the British share of the reparations, including the extinction of advances to Belgium. The ships allotted to this country formed roughly 70 per cent. of the whole tonnage to be surrendered. The obligation upon Germany to deliver ships by way of reparation was laid down in Annex III. to Part VIII. of the Treaty,* and the Reparations Commission had the power under Art. 235 to demand the delivery before May 1, 1921, of ships other than those referred to in this Annex, but in the

* "Germany recognises the right of the Allied and Associated Powers to the replacement, ton for ton (gross tonnage) and class for class, of all merchant ships and fishing boats lost or damaged owing to the war. Nevertheless, and in spite of the fact that the tonnage of German shipping at present in existence is much less than that lost by the Allied and Associated Powers in consequence of the German aggression, the right thus recognised will be enforced on German ships and boats under the following conditions: The German Government, on behalf of themselves and so as to bind all other persons interested, cede to the Allied and Associated Governments the property in all the German merchant ships which are of 1,600 tons gross and upwards; in one-half reckoned in tonnage, of the ships which are between 1,000 tons and 1,600 tons gross; in one-quarter, reckoned in tonnage, of the steam trawlers; and in one-quarter, reckoned in tonnage, of the other fishing boats." —Peace Treaty: Part VIII., Annex III., Clause 1.

event did not exercise this power. Some delay, doubtless unavoidable, occurred in finally allotting to Great Britain the steamers assigned to her under the Treaty, but by the summer of 1920 it had become possible to draw up a programme for the handing over of the ex-enemy steamers to the British Government. In the meantime, a transaction of a remarkable character had taken place, which was to suggest to the British authorities a method of disposing of the ex-enemy tonnage.

## Sale of Standard Ships.

In 1919, Lord Inchcape had taken over from the Government, on his own account, for re-sale to British owners, 196 standard ships, totalling upwards of 1,400,000 tons gross, which had been contracted for by the Government owing to the urgent necessity of replacing tonnage destroyed by the enemy. In acquiring these vessels he had stated that any profit made would ultimately accrue, not to himself, but to the purchasers in reduction of their purchase prices, and this was done. The disposal of these ships resolved itself into three main deals as the ships in successive groups became available for marketing. The first group included eleven "A" and thirty-seven "B" steamers, each of 8,130 tons; two "E" steamers of 7,020 tons; six "F" steamers, each of 10,790 tons; three "F 1" steamers of 9,000 tons; eight "G" steamers (insulated for the carriage of cargo at low temperatures) each of 9,800 tons; eight "G" steamers, not insulated, 10,800 tons; and two "N" steamers each of 10,500 tons. The tonnage figure is, in each case, that of the dead-weight capacity of the individual ship. The initials were used to distinguish various types of ship, each type having been especially designed for the particular trade in which it was intended to employ the vessels. These seventy-seven steamers, aggregating 681,820 tons dead-weight, realised a sum just short of £16,000,000.

The second deal included in its "supplementary" list three "A" and six "B" steamers, 8,130 tons dead-weight; three "F" type steamers, 10,790 tons dead-weight; three "N" steamers each of 10,500 tons, besides thirty-one "C" ships of 5,010 tons; one "D" ship of 3,000 tons; nine "H" ships of 3,870 tons; and twenty-three coasting steamers averaging 1,500 tons dead-weight. These again fetched prices totalling close on 8½ millions sterling, their dead-weight tonnage aggregate being 375,001 tons.

In the third deal were included forty newly built steamers which, from the date of their completion, had been running in the service of the Shipping Controller. Of these, twenty-six were standard ships of British construction; the remaining fourteen had been built abroad—one or two in Japan, the remainder at British Empire ports. The total dead-weight tonnage of this group of steamers was 343,788 tons, and they realised upwards of nine million pounds.

The aggregate of tonnage disposed of in the three deals was 1,400,609 tons dead-weight, and the amount realised was, in round figures, £35,000,000. These transactions were completed between January, 1919, and June, 1920, at a total administrative cost of

£850—equal to one-412th part of £1 per cent.—and as has been stated, "without profit to the vendor or to his firms or companies." The deals took place in a time of great, if short-lived, prosperity in the shipping trade, the steamers were in the majority of cases of British construction; some were new, others had been running for only a short time, and others, again, were still in their builders' hands.

In accepting the Government's invitation in the autumn of 1920 to tackle the much more arduous job of launching on a depressed market a huge block of ex-enemy tonnage, Lord Inchcape was, it may be assumed, actuated, to some extent, by considerations which had led him to purchase and sell the standard ships in the previous year. The temporary direction, during the war and afterwards, of British merchant shipping by a specially constituted Government Department, had generated an ambitious dream, in the minds of some few of the transitory officials, of retaining control of the ship-owners' property and functions in perpetuity, and a scheme for the nationalisation of British shipping took shape, was discussed in a small press campaign, and found—in principle—ready acceptance by political theorists. So long as the Government—the war ended—continued in possession of the standard ships, the agitation, limited though it was in volume and area, constituted an embarrassment of which the Government was, doubtless, glad to be rid.

In the case of the ex-enemy steamers, however, the arrangement was of a different nature. It was not to be expected that Lord Inchcape could, as in the case of the standard ships, buy the vessels at a rate per ton on the dead-weight capacity, for their condition was unknown and they varied greatly in age, type and usefulness. It was accordingly arranged that he should sell them for the Reparations Commission without remuneration.

Referring, at the annual meeting of the P. & O. stockholders in December, 1920, to the ex-enemy steamers, Lord Inchcape frankly stated that he had felt it to be his duty to do what he could in the way of selling them in order to relieve the Government of the possible necessity of running them themselves, which, he added, would have been disastrous from every point of view.

### The Opening of the Sale.

On September 9, 1920, the first public announcement was made inviting offers for forty ex-enemy passenger steamers; to this list was added, on the following day, two notable ships—the still uncompleted Bismarck of 56,000 tons gross, and the Imperator, built in 1912, of 51,969 tons gross. The prospect of selling these huge vessels was not a rosy one, for their market was practically confined to two possible purchasers, and was not improved by the almost simultaneous announcement that the Leviathan, retained in the hands of the United States Government, was rotting in New York harbour, because it was estimated that an outlay of £2,000,000 would be required to re-condition her. Eventually, on February 11, 1921, the White Star Line acquired the Bismarck, afterwards re-naming her Majestic, and the Cunard Line purchased the Imperator—now

known, under the British flag, as the Berengaria. The first list thus included passenger steamers which had formed the cream of the German liner service, built before the war as part of the challenge to British supremacy on the world's trade routes. The Columbus, a new passenger steamer of 35,000 tons gross, was sold in June last. The München of 18,000 tons gross, also new, first offered in January, was sold in July of this year.

An agitation was at the outset commenced, and continued intermittently throughout the sales, for the offer of the ships by auction. This method had, however, been early considered and rejected, for the best auctioneers in London, asked to indicate the probable resultant of sale by this method, of 31 specified steamers, advised that bids of £709,400 might be expected for them. These same vessels were eventually disposed of by private treaty for £1,078,550. So that the principle of open market should be maintained, all the ships as they became available were extensively advertised in the public press, the notices, up to June, 1921, stipulating that offers would be received from British nationals only, and this principle was only departed from when it appeared, from a lull in the sales, that the British market was running dry. But some of the vessels were, in exceptional circumstances, put up to auction. The Austria, 3,855 tons dead-weight, built in 1899 and in poor condition, was offered at auction in December, and withdrawn for want of bids. She was eventually sold by private treaty for £7,500. On the same occasion the Hebe, 4,450 tons dead-weight, built in 1890, was sold to shipbreakers for £4,500, and the Prinz Hubertus, 5,300 tons dead-weight, extensively damaged by fire, fetched £10,000. In April, 1921, the Uhlenhorst, 3,290 dead-weight, built by Blohm & Voss in 1894, was auctioned at the Baltic Exchange and knocked down for £1,000; the Kosma, 2,098 tons dead-weight, lying in the Tyne with engines dismantled, was sold by auction in May to shipbreakers for £675; the Scotia, 3,800 tons dead-weight, was put up in June and sold for £1,150; the Graf Waldersee, 13,193 gross tons, after being repeatedly advertised, was sold by auction in August last for £4,000—these four prices being slightly in excess of six shillings per ton dead-weight or gross.

## The Twelve Months' Record.

In the three months ending December 7, 1920, there were offered for sale 45 passenger steamers, 214 cargo steamers, 5 sailing ships, and 24 trawlers—all former possessions of German owners. In the succeeding three months, ending March 7, 1921, one passenger ship and 40 cargo steamers were added to the list of vessels for disposal, which included 21 prize vessels. In the three months ending June 7, the list was further reinforced by 20 cargo steamers, including 1 prize vessel and 4 vessels classed as "additional steamers," 9 "prize" sailers (sold by auction), and 5 trawlers. In the three months ending September 7, 71 vessels were also offered for the first time, of which 54 were cargo steamers, 3 passenger vessels, and 14 sailing ships, or, in the twelve months ending September 7, 1921, a total of

434 vessels, made up of 49 passenger steamers, 328 cargo vessels, 28 sailing ships, and 29 trawlers, of a mixed aggregate, gross or dead-weight, of approximately 2,500,000 tons.

By October 19—40 days after the opening of the lists—48 steamers, totalling 247,409 tons, of varying type and age, and of an average size of 5,000 tons, had been sold for £4,786,975, an average of £19 7s. a ton—not far short of Mr. Lloyd George's anticipation on July 22 of £20 a ton—an average which, however, in the increasingly unfavourable market conditions, could not possibly be maintained. Shortly before the opening of the ex-enemy steamer sales, steamers offered at auction on private account had been withdrawn for want of bids, freights were low and were falling still lower, labour troubles, involving stoppage of work in many industries vital to our foreign trade, were current, and the nation was already threatened with a strike of coal miners, so that, as one writer phrased it, already, within the weeks preceding the first offer of the German ships, the bottom had fallen out of the market. By November 11, 74 ships, of 354,870 tons measurement, had been sold; by December 1, 85 steamers; by December 8, 93, and by January 3, 116 had been disposed of. On February 8, it was announced that all steamers allotted to the British Empire had been advertised, excepting 38 steamers and 12 sailing ships which were interned in South American ports. The gross tonnage of the passenger steamers sold to that date was 168,497 tons and the dead-weight tonnage of the cargo steamers 755,531 tons, a mixed total of 924,028 tons. Of the unsold vessels (excluding trawlers, etc.), the gross tonnage of the passenger steamers was approximately 332,654 and the dead-weight of the cargo steamers 715,132, a mixed aggregate of 1,047,786 tons. In March, 17 vessels, aggregating 75,040 gross tons, realised £548,100, or £7 6s. per gross ton. In the week ending May 18, 9 ships were sold, and in the 21 working days preceding that date, 19 vessels were sold. On May 25, Sir Robert Horne stated in the House of Commons, in answer to a question, that of the vessels advertised to date, 202 ships had been sold for £14,523,074, and that 85 merchant ships and 22 trawlers were still available for purchase. A few of the allotted vessels had meantime been withdrawn by the Reparations Commission.

## Decline in the Value of Tonnage.

In the months preceding the initiation of the ex-enemy tonnage sales, the value of new steamers had fallen considerably, while the cost of building had continued to advance. A standard "C" ship of 5,000 tons, which fetched, in February, 1920, £180,000, commanded, eight months later, a price no higher than £101,000. Two standard "A" ships, 8,100 tons, which fetched, in June, 1919, £207,000 and £235,000 respectively, realised, in October, 1920, no more than £163,000 each. Meantime steel ship plates (Scotland) had advanced from £17 10s. in May, 1919, to £27 per ton in October, 1920; angles from £17 to £26 10s.; boiler plates, from £19 10s. to £31 10s.;

and, since 1914, shipyard wages had, moreover, risen 200 per cent. General time charter rates had fallen from 30s. per ton dead-weight a month in January, 1920, to 15s. in September, while the cost of bunker coal in South Wales had risen from 49s. in July, 1919, to 80s. per ton in October, 1920. (*Financial Times*, November 11, 1920.)

It was not long before the cry was raised that the British shipping trade was being swamped by ex-enemy tonnage. This was, however, considered to have but slight foundation in fact, for many of these vessels had, pending a decision as to the method of their disposal, been running for some considerable time in international trades on account of the Ministry of Shipping, under the management of British owners, but with latent Government control of their voyages, and were only withdrawn from this employment as the time arrived to offer them for inspection and sale. Running under skilled British management, their value in the market was, in many cases, enhanced. But a number of the ships were old and in bad condition, and some had been built for special trades which the war had, for the time being, destroyed. From this agitation there inevitably proceeded suggestions that Great Britain would have profited more if Germany had retained her steamers. As early as September 15, 1920, a rumour, officially dismissed as of German origin, gained currency in the world's press of the intended re-sale of 40 ex-enemy liners and a number of cargo steamers to their former owners. Germany's tonnage in 1916 was computed at 3,890,542 tons; by January, 1921, it had been reduced to 672,671 tons, the vessels remaining to her averaging only 591 tons gross, and she had at that date surrendered to the Reparations Commission 2,054,729 tons, of which 1,477,839 had been allocated to Great Britain. It was at this time (February, 1921) pointed out by an influential shipping journal, that the British market's limit of absorption had apparently been reached—that the only nation needing tonnage was Germany, and that the possibility of the disposal to Germans of the 105 vessels still unsold should be considered. A few weeks earlier another very influential paper had commented with some disfavour on the alleged chartering by their new British owners of ex-German steamers to a Dutch firm which had put the steamers on the berth in Hamburg to load for India. Such a charter was exceptional; but obviously the first necessity of the British owners was to find profitable employment for their ships; and it is difficult to see how, in the then state of the freight market from British ports, there could have been any objection to the course adopted, especially when it is considered that the charter money found its way into the coffers of a British firm. To deprive the purchaser of an ex-German steamer of access to the international freight market, would have been to impose a condition of ownership for which there was no precedent, and the case differed from that of British firms who were already loading at Hamburg, only in the interposition of foreign charterers. The matter is referred to at some length, as it was the first murmur of a newspaper campaign which has urged that it would be preferable to lay up, or break up, the ex-German steamers rather than let them be used for the

service of Germany's foreign trade, some revival of which was, and is, widely held to be essential to the economic reconstruction of Europe.

The Ministry of Shipping came to an end on March 31, 1921. In presenting the supplementary shipping estimates to the House of Commons on the 12th of that month, Colonel Leslie Wilson took occasion to point out, in answer to a member's suggestion, that the sale of the ex-German ships was not the cause of cancellation of British shipbuilding orders, but that such cancellations were due to the high cost of material and labour. He further stated that the Ministry, in its interim operation of the ex-enemy steamers, showed a profit of £1,171,749 for the twelve months ended January, 1920.

### Sales Open to the World.

In the course of the sales, representations were made urging that British masters and officers who had served in ex-enemy steamers under the Ministry should be allowed, where possible, to continue such employment under the vessels' purchasers, and it transpired that already there was regularly sent to purchasers of such steamers an official request that officers employed under the Ministry should, if possible, be so retained. In forwarding a copy of this letter to the Imperial Merchant Service Guild, the re-settlement officer of the Ministry added, as the fact was, that Lord Inchcape, through his selling organisation, was using his best influence with purchasers for the retention of such officers, many of whom were senior masters with excellent records who had had, owing to the loss of their ships during the war, to seek temporary employment in Ministry ships.

On February 16, a new feature of the sales announcements was the offer of 14 ex-German cargo steamers, taken in prize during the war, for purchase by British nationals, allies or neutrals, an announcement which admitted the whole world with the exception of citizens or corporations of the ex-enemy countries, and this may be taken to have been the first official recognition of the need which had arisen to widen the market. A month later, of 100 ships recently offered but few had found purchasers, and at this time a meeting of the Council of the Chamber of Shipping was called so that Lord Inchcape might lay the whole matter before his brother shipowners. It was already being urged by responsible organs of the shipping press, that the Government ought to raise the embargo on the sale of the surrendered vessels abroad, and even to admit German purchasers. Exactly contrary views were expressed by another journal, which thought that the alternative of laying them up should be adopted, or the ships sold to British nationals for what they would fetch to be broken up.

At the meeting of the Chamber of Shipping, Lord Inchcape stated that while 168 ships had been privately disposed of to British nationals, a good many remained to be sold, that the demand had slackened, and it had been suggested that some arrangement might be considered whereby the market for the ships would be thrown open to the

whole world. After much discussion, the meeting resolved that there ought to be no sales of the ex-enemy vessels to Germans, and the resolution, in its postulation that transfers to foreigners should be debarred for a period of five years, implied that sales should be confined to British buyers. The resolution could, of course, have no binding effect on the Government, and it was officially stated, a few days later, that no decision had been taken by the authorities concerned to depart from the method of disposal previously followed. At the same time, it transpired that, during the week in which the meeting occurred, purchasers had been found for fourteen steamers. This rate of selling was not maintained, and the further pause in the sales was doubtless intensified by the continuance of the Government's practical embargo on the sale to foreigners of obsolescent British tonnage. That the conversion of such tonnage into cash by sale to foreign owners would have accelerated British purchase of the more modern among the ex-German vessels, there can be no doubt, but it was not until August 1 that Mr. Baldwin announced in the House of Commons the intention of the Government to remove the ban on the disposal of British ships abroad.

### A Lead from the East Coast.

Among British shipowners, it was left for those of the East Coast fairly and squarely to look the truth in the face. At the end of May, the North of England Steam-Ship Owners' Association, with Sir William Noble—ex-President of the Chamber of Shipping—in the chair, resolved that the sustained fall in the value of tonnage was due to the restriction of the market for ex-enemy ships to British owners, and called upon the Government to remove the prohibition of the sale of British or ex-German tonnage to other nationalities. On June 9, Major Barnes in the House of Commons called attention to the terms of this resolution, urging their adoption by the Government. Clearly not much was to be expected at this time from the market in Great Britain, and the imminent prospect of a forced sale in Europe of large blocks of tonnage by the United States Government, whose experiment in shipowning had proved, as it was bound to do, a ghastly and ruinous failure, brought the matter to a crisis. On June 18, further notice was given by Lord Inchcape, acting with the full concurrence of the Reparations Commission and the Government, that vessels officially offered for sale on that date, if not bought by British nationals by the end of the month, would be sold to "foreign buyers"; and this was followed on July 1 by the further announcement that the ships then already advertised and still unsold, were available for sale to buyers of any nationality throughout the world, which of course included those of German nationality.

It is perhaps too soon yet to visualise the full effects of this step, but the effects, so far as can be observed, have been curious and, except by a few, unexpected. German shipowners, failing a supply of ships by any readier means, were already engaged in a frenzied programme of new construction, and the capacity of their yards had been greatly developed during and after the war. One condition

of the Peace Treaty in relation to shipping reparations, was that Germany should, for a term of years, deliver annually 200,000 tons of new shipping to the Allies, and, from a German source, the claim was recently put forward that German yards could produce this without retarding their normal output. It seems doubtful if this condition will be insisted upon, for the only way satisfactory to this country by which Germany could discharge her obligation would be to sublet the contract to British shipbuilders. But an immediate effect of the possibility of buying back their former vessels has been the cancellation of German orders to their own yards; and, incidentally, the prolonged and somewhat heated discussion in our own press of the change of policy has resulted in a briskly renewed inquiry by British owners for ex-German tonnage, so that, of a considerable number of vessels disposed of since the new regulation became effective, the large majority have passed to British ownership, and there seems every prospect that the percentage of the total sales to foreign buyers will finally be almost negligible. At the time of writing (October 4, 1921), of the vessels offered, 417 have been sold, and have realised not far short of twenty million pounds sterling.

In the course of a happy speech at the dinner given on July 8 to commemorate Sir Joseph Maclay's success and popularity as Shipping Controller, Lord Inchcape remarked that he had lately been disposed to wish that every German ship had been sent to the bottom of the sea, but he added that in the privacy of that gathering and in the strictest confidence, he would tell them that the ships he had sold, and, he was thankful to say, had been paid for, were the most indifferent of the lot, and that those which he had still to dispose of were "far and away the best of the bunch." His task, now approaching its conclusion, has been no easy one. It has been conducted with characteristic good humour, fairness and a keen eye to business, and none will be found to deny that the Government and the nation are fortunate in having left a prolonged and difficult series of transactions in such capable hands.

## CHAPTER XII.

### The Future of German Shipping.

The Germans still believe that their future lies on the water. German shipping, which the war had wiped out, is rapidly reappearing, but it is not easy to gauge correctly the progress which is being made in recapturing lost trades, because Germany is availing herself largely of foreign tonnage on charter. For the rest, a partnership has been concluded between the Hamburg-America and German Lloyd lines, on the one hand, and two of the leading American Companies, on the other, while some progress has been made towards re-establishing German predominance in the Baltic by a compact with the Soviet Government. Owing to the interplay of political and economic factors, the arrangements which the Germans have made with the Americans and Russians may prove important factors in future years.

The shipyards of Germany are very active; there is no apparent lack of raw materials, and the workers are labouring long hours at low wages. This movement is being sustained by the money which the German Government is paying by way of compensation to shipowners for the losses they suffered under the Peace Treaty. German shipping firms are obtaining new tonnage at a low price, and, owing to the low price of coal and the reasonable attitude of the seamen, it is believed that it will be possible to operate German ships at about half the cost which is incurred in running British ships.

A feeling of optimism is sustaining German shipbuilders and shipowners. They are utilising to the full the advantages which the low German exchange confers upon them, and are benefiting, not a little, from the political and labour unrest which has occurred since the Armistice in the United Kingdom as well as in other European countries. German ports, particularly Hamburg, are once more throbbing with activity, after being deserted during the period of the war, and all classes of the nation are co-operating to re-establish Germany as a great commercial nation with her mercantile flag in every sea. Many Germans of knowledge and experience believe that within a comparatively few years they will succeed in completely re-establishing themselves by sea. In these circumstances, it may prove not unprofitable to review the situation in the hope of reaching a correct judgment of the foundations on which German hopes rest.

### Surrenders under the Peace Treaty.

Previous to the war, the German merchant marine was the second largest in the world. It was destroyed by the Treaty of Versailles, which stated in Annex III. of the section dealing with Reparations:

The German Government, on behalf of themselves, and so as to bind all other persons interested, cede to the Allied and Associated Governments the property in all the German merchant ships which are of 1,600 tons gross and upwards; in one half, reckoned in tonnage, of the ships which are between 1,000 tons and 1,600 tons gross; in one quarter, reckoned in tonnage, of the steam trawlers; and in one quarter, reckoned in tonnage, of the other fishing boats.

In addition to practically all her sea-going ships, Germany was required to hand over a considerable portion of her very important river fleet, and to build over a period of five years 200,000 tons of shipping annually for the Allies; but effect is unlikely to be given to the latter stipulation in view of the existing over-supply of tonnage.

What will be the effect of Germany's defeat upon her merchant marine? Will it lead to the eclipse or to the disappearance of the German flag on the ocean, or will the Germans succeed in re-creating their shipping and in assuming once more that important position on the sea which they held in the past? If we wish to form an opinion on the subject we should briefly survey the history of the German merchant marine, for tradition, even if it is only recent tradition, has a very potent influence upon the minds of men.

Old Prussia was a military inland State. It had practically no sea ships. Previous to the war of 1870, the German shipping trade was monopolised by the independent republics of Hamburg and Bremen. The creation of the Empire brought these two ports under the German flag. The German business men urged upon Prince Bismarck the creation of a great merchant marine, and they succeeded in obtaining his support. Government assistance was provided in various forms. Germany's shipping and shipping trade increased rapidly *pari passu* with the extraordinary expansion of Germany's manufacturing industries and of her foreign commerce. The progress made may be seen from the following table.

GERMAN MERCHANT STEAMSHIPS.

| | |
|---|---|
| 1871 . . . . . . . . . | 81,994 tons net. |
| 1881 . . . . . . . . . | 215,758 „ „ |
| 1891 . . . . . . . . . | 723,652 „ „ |
| 1901 . . . . . . . . . | 1,347,875 „ „ |
| 1910 . . . . . . . . . | 2,349,557 „ „ |
| 1913 . . . . . . . . . | 3,153,724 „ „ |

For many years the Germans had bought their best ships in England. Bismarck made it a condition, in granting subsidies to shipping lines, that the ships required should be built in Germany, and as far as possible with German material. The result was that the German shipbuilding industry rapidly grew from insignificance to great importance. Its advance is shown by the next table.

IRON AND STEEL SHIPPING BUILT IN GERMANY.

| | |
|---|---|
| 1880 . . . . . . . . . | 23,986 register tons. |
| 1885 . . . . . . . . . | 24,554 „ „ |
| 1890 . . . . . . . . . | 100,597 „ „ |
| 1895 . . . . . . . . . | 122,712 „ „ |
| 1900 . . . . . . . . . | 235,171 „ „ |
| 1909 . . . . . . . . . | 326,318 „ „ |
| 1913 . . . . . . . . . | 458,755 „ „ |

The far-seeing and energetic policy inaugurated by Prince Bismarck was powerfully aided by the expansion of Germany's oversea trade. From year to year, the proportion of Germany's trade carried by German ships increased, while that carried under foreign flags declined. The official German statistics given in the table below show the advance made.

ARRIVALS IN GERMAN HARBOURS.

| | Under the German Flag. | Under Foreign Flags. | Total. |
|---|---|---|---|
| 1873 . . | 2,998,728 tons | 3,241,865 tons | 6,240,593 tons |
| 1883 . . | 4,520,120 „ | 4,866,698 „ | 9,386,818 „ |
| 1893 . . | 7,627,346 „ | 6,994,288 „ | 14,621,634 „ |
| 1903 . . | 12,284,086 „ | 8,601,962 „ | 20,886,048 „ |
| 1913 . . | 21,231,342 „ | 13,540,835 „ | 34,772,177 „ |

Between 1873 and 1913, arrivals under foreign flags increased a little more than fourfold, while arrivals under the German flag increased a little more than sevenfold.

## THE TRAMP AND THE LINER.

The great characteristic of the British merchant marine has always been the predominance of the tramp ship. The great characteristic of the German merchant marine was the predominance of the liner. At one time, the fastest liners on the ocean flew the German flag. Tramp shipping was neglected. The two leading shipping lines, the Hamburg-America Line and the North German Lloyd, were the largest companies in the world. At the outbreak of the war, they possessed together a tonnage of 2,000,000. The remaining shipping companies also specialised in ships of the liner type. In 1914, more than half of Germany's tonnage consisted of ships of 4,500 tons and more, and more than half of her shipping was less than ten years old.

Just before the war, Germany began the development of tramp services. The great struggle prevented her taking up this branch of the shipping trade with energy.

There was some good reason why Germany specialised in liners, notwithstanding the rapid development of her foreign trade, which ought to have caused her to embark upon the tramp business. For many decades, there had been a great emigration from Germany. The shipowners of Hamburg and Bremen had engaged in the transport of emigrants for decades before the creation of the German Empire. The emigrant traffic was for them a most valuable resource. Between 1871 and 1894, nearly 2,500,000 Germans left their country. The peak of the emigration wave was reached in 1881, when 220,902 Germans went oversea. At the beginning of the 'nineties German emigration shrunk with extraordinary rapidity, as follows:

| | |
|---|---|
| 1891 . . . . . . . | 120,089 emigrants. |
| 1892 . . . . . . . | 116,339 „ |
| 1893 . . . . . . . | 87,677 „ |
| 1894 . . . . . . . | 39,204 „ |

The alarming shrinkage of the stream of emigrants from Germany was a heavy blow to the German shipping lines, for their prosperity was bound up with it. While emigration from Germany was rapidly declining, emigration from Russia and Austria-Hungary was rapidly increasing. The German shipowners hit upon an ingenious system whereby Russian and Austro-Hungarian emigrants might be forced to make use of German ships. In 1894, when German emigration had suddenly shrunk to one-third the average, a line of control stations was established on Germany's eastern frontier. Nominally these stations were to prevent the importation of cholera and other diseases into Germany on the part of foreign emigrants who travelled through Germany in order to go on board a ship. However, the management of the control stations was handed over to the Hamburg-America Line and to the North-German Lloyd, and foreign emigrants were turned back under various pretexts unless they arranged for passage by a German ship.

### The Importance of the Emigrant Traffic.

Germany occupies a most favourable geographical position on the Continent. Hamburg and Bremen are not only the principal harbours of Germany but also of Austria-Hungary and Russia, especially with regard to the passenger traffic. The most important trade arteries of the Continent are the Rhine and the Elbe. Germany's geographical position and the unscrupulous use made of the control stations, notwithstanding England's protests, gave to the Germans the bulk of the huge and ever growing emigrant traffic from Eastern and Southern Europe. The Report of 1918 on the Shipping and Shipbuilding Industries gave the figures relating to the third-class continental passenger traffic, from which figures in the next table, have been prepared.

Statistics of Emigrant Traffic.

| | Number. | | Per cent. | |
|---|---|---|---|---|
| A. From United Kingdom ports, by transhipment or by subsequent call at a French port: | | | | |
| British Lines | 78,000 | | 9 | |
| American Line | 23,333 | | 3 | |
| | | 101,000 | | 12 |
| B. From Continental ports by direct services: | | | | |
| British Lines | 91,000 | | 11 | |
| Enemy Lines | 417,000 | | 50 | |
| Other Lines | 220,000 | | 27 | |
| | | 728,000 | | 88 |
| Total (all lines) | | 829,000 | | 100 |

It will be noticed that the German shipping lines had by far the most important part of the emigrant traffic. Compared with their share, the share falling to England was very small. The emigrant traffic was an invaluable resource to the German shipping trade. It was the foundation of their prosperous liner business and it enabled the Germans to build up that wonderful fleet of fast passenger liners

which was so conspicuous a feature of their shipping trade. The emigrant traffic is a most important factor. The steerage passenger is as predominantly important to the liner as the third-class passenger to the railway. Liners which are deprived of the emigrant traffic cannot possibly flourish. That should constantly be kept in mind.

The German merchant marine has disappeared. If we wish to form an opinion as to whether it will be re-created or not, we must take note of the abilities and ambitions of the German people and of their Government, and also of the dominant economic factors which are bound to influence their decisions.

Old Prussia was a militarised and principally an agricultural State which possessed no important harbours and which had no maritime inclinations. The views of the people changed when Hamburg, Bremen, and Lübeck, the old Hanseatic towns, became part of the German Empire. The maritime spirit and the maritime ambitions of the inhabitants of these three ports seized hold of Germany's imagination. The old Hanseatic motto: *Navigare necesse est, vivere non est necesse*, was constantly quoted in Germany, and became the national watchword. Maritime ambition and pride in their merchant marine became universal in Germany. Had it not been for these sentiments, the German Navy League would never have become the most powerful organisation in Germany, nor would the Germans have been willing to spend untold millions on the building of their war fleet.

Germany's defeat on the sea and the disappearance of her merchant marine have not destroyed that spirit. That may be seen from innumerable books, pamphlets, newspaper articles, lectures, and speeches which have been published. The Germans mean to create once more a powerful merchant marine and their determination is supported not merely by vague sentiment and ambition, but also by business considerations. The figures illustrating the progress of Germany's shipping trade and of Germany's shipbuilding trade, given in the beginning of this article, show that shipping and shipbuilding were among the most prosperous and the most progressive branches of German economic life. Between 1881 and 1913, the tonnage of German steamships had increased fifteenfold, and the tonnage of iron and steel ships built in Germany had increased twentyfold. The prosperity and the progress of German shipping and of German shipbuilding were as extraordinary as the prosperity and progress of the German chemical industry and of the German iron and steel industry, and Germans believed that the expansion of their shipping and shipbuilding trades had only begun. We can, therefore, understand that the Germans mean to reconstruct their shipping with the utmost speed. Their determination is, of course, sharpened by the economic pressure caused by their defeat.

## Germany's War Losses.

The Germans have lost vast and very valuable wealth-creating resources. Large portions of their best agricultural soil have been transferred to Poland, Denmark, and France. The bulk of their iron ore, and a considerable portion of their coal and potash, have been lost

to the victors. Their colonies and the bulk of their foreign investments have disappeared. Millions of excellent workers have become the subjects of other countries or have been killed or crippled in the war. A huge war debt has been created and Germany has to pay gigantic sums to the victors. The Germans realise that they can save themselves from national bankruptcy only by developing their trade and industry with the utmost energy and by concentrating their efforts upon the most promising branches. Therefore, the nation and its Government have resolved to rebuild the merchant marine regardless of cost, especially as Germany possesses vast natural advantages which impel her to embark once more on the sea.

Germany occupies the central position on the European continent. The country is opened up by a unique system of deep and gently flowing rivers which are navigable for hundreds of miles, which can easily be deepened and connected by lateral canals at a low cost, and which in part are already so connected. The great German rivers are most important international trade routes. Previous to the war, the principal harbour of Austria Hungary was not Trieste but Hamburg, while Eastern France, Switzerland, and Northern Italy sent a large portion of their trade along the Rhine. The construction of canals connecting the Rhine with the Elbe and with the Danube, and the improvement of the connections with the French system of inland waterways, are bound to increase greatly the international trade in goods flowing through Germany. The German industries will be stimulated to the utmost by the economic pressure caused by the defeat. Last, but not least, unprecedentedly hard times experienced by Germany and her neighbours are bound to lead to equally unprecedented emigration from Europe. It is clear to all German business men that the future offers absolutely unparalleled chances to their shipping trade. Besides, they are aware that Germany's export trade would be placed in a very unfavourable position if it had to rely entirely on foreign ships. The hope of vast gain and the pressure of necessity combined, together with the influence of the natural factors which have been outlined, have suggested to the Germans that they should take once more to the sea and should spare no expense in achieving their ambition.

Previous to the war, the iron and steel industry was the leading German industry. It occupied as predominant a position as the cotton industry occupies in this country. Before the war, Germany produced twice as much iron and steel as the United Kingdom. The industry was growing at a miraculous rate, while the iron and steel trade of this country was stagnating. The German iron masters hoped to dominate the world with their wares. They exercised a very potent influence over the Government and its policy.

The German iron and steel men have not lost hope, and their influence over the Government is, at present, greater than it has ever been in the past. Although 80 per cent. of Germany's iron ore has fallen to France, the German iron and steel men hope to re-establish their predominance by suitable international arrangements which will furnish them with the raw material which they require, and they hope that the unprecedented demand for iron and steel and

engineering goods of every kind will give them the best chances for selling their productions. In order to strengthen their position, they have not only entered into arrangements for the supply of the raw materials required, but have endeavoured to increase the efficiency of the works by the elimination of unnecessary competition, by getting rid of unnecessary middlemen, and by developing their old policy of combination to the utmost. The Kartel system has taken a most extraordinary development. Concentration of works of every kind is progressing apace. Coal mines, iron-ore mines, iron works, steel works, engineering establishments and shipbuilding establishments are so rapidly being brought under united control that it is difficult for the outsider to follow developments; the position changes almost from day to day. If the policy of unification, which has been so extraordinarily successful in Germany in the past, should prove as successful in the future, the power of the German industries to undersell their foreign competitors will be greater than it has been ever before. Germany's competitive strength in industry and commerce will, of course, be increased still further if peace and order are maintained in the country, and if the German workers continue working longer hours at much lower wages than the workers in England and America.

### Government's Attitude towards Shipping.

The German Government is obviously convinced that the resuscitation of the German merchant marine is one of the most important tasks of the country. Besides, the pressure of the iron and steel interests is bound to influence their decisions. The German Government has determined upon compensating the shipowners for the ships which they have lost. The gigantic sum of M.11,970,000,000 has been voted for that purpose, and payments are made under the condition that the money granted must be invested in shipping. A great building programme has been laid down. The German shipbuilding industry may experience a period of the greatest activity.

Previous to the war, the output of merchant ships had increased from a few thousand tons in 1880 to nearly half a million tons in 1913. In addition, the German yards built a very large tonnage of warships. During the war, many of the shipyards were enlarged and additional establishments were begun. The war has given an impetus to the fabricated ship. Optimistic Germans are calculating that, by making use of their facilities for building ships for commercial purposes, by developing the newly established yards and by fabricating standard ships inland and assembling the standardised portions on the sea border, they will be able to turn out a tonnage which will rapidly grow to 2,000,000 tons a year. If these optimistic forecasts should be realised, and even if they should be realised only in part, the fact that, according to the Treaty stipulations quoted at the beginning of this article, Germany may be called upon to build 200,000 tons of shipping per year for the Allies would hamper her shipbuilding and shipping industries only very slightly.

### UNFAIR COMPETITION.

In trying to forecast the future of the German shipping industry, we must remember that that country has prospered in the past very greatly not only owing to the circumstances previously described, but also owing to certain factors which may be summarised in the words "unfair competition." Unfair competition was by no means restricted to the abuse made of the control stations, to which reference has already been made. Unfair competition, in the past, has been a most potent weapon used by the German shipping men, and it has proved so extraordinarily successful that it has become a tradition which cannot be easily uprooted unless irresistible pressure is exercised. By the Peace Treaty, the Germans bound themselves to abandon the unscrupulous use made of the control stations. Article 322 states:

> Germany undertakes neither to impose nor to maintain any control over transmigration traffic through her territories beyond measures necessary to ensure that passengers are *bonâ fide* in transit; nor to allow any shipping company or any other private body, corporation or person interested in the traffic, to take any part whatever in, or to exercise any direct or indirect influence over, any administrative service that may be necessary for this purpose.

Article 368 lays down:

> Germany shall not apply specially to such through services, or to the transportation of emigrants going to or coming from the ports of the Allied and Associated Powers, any technical, fiscal, or administrative measures, such as measures of customs, examination, general police, sanitary police, and control, the result of which would be to impede or delay such services.

Although these provisions are absolutely explicit, Germany has tried to evade them by withholding emigrants' licences from British lines, as Sir Alfred Booth complained at the annual meeting of the Chamber of Shipping on February 25. As he wittily remarked: "The vast Hinterland which Germany possesses and the power she has of controlling the traffic through Central and Eastern Europe, I am afraid, afford her a temptation too great to be absolutely resisted."

In addition to making unfair use of the control stations, which existed nominally only for sanitary purposes, the German Government gave to the national shipping trade a very important unfair advantage by means of privileged railway rates granted by the State railways to German exports, especially if they were shipped in German vessels. That insidious form of favouring home industries has lately been reinforced by colossal subsidies granted to Germany's industries and export trade in the unusual form of a railway deficit. During the last year, the State railways were run at a loss of M.16,000,000,000. This means, in other words, that passengers and goods were transported at considerably less than cost price, and that the difference was made up by the taxpayer. This deficit is, therefore, a disguised subsidy which is of the greatest advantage to German industries and to Germany's export trade. During the present year also the railways are being run with a huge loss. England will do well to watch carefully the way in which the German railways are manipulated for industrial and commercial ends.

A third form of unfair competition consisted in rate cutting which was continually practised by the German shipowners. The Booth Report on the Shipping and Shipbuilding Industries of 1918 stated with regard to it:

"These methods, characteristic of German trade in general, were adopted by German shipping. Profits realised in one market were used for undercutting in another. The close organisation of the German lines made them a great combine able and willing to undersell their competitors and to 'squeeze' them in the Conferences. Aided by the control stations and the State railways, they possessed means of pressure which could be used with serious effect against their more loosely organised competitors."

It would be surprising in view of the advantage which Germany has derived from the use of unfair methods, if these methods should be abandoned by her in the future. Unfortunately they have become a tradition with her business men.

Germany's shipping trade consisted chiefly of the liner business, and she specialised in the Atlantic trade, in the trade between Europe and the United States. Germany is endeavouring to regain that most important trade by partnerships which her principal shipping lines have concluded with important American interests. It must therefore be expected that German influences will urge the Americans to employ on the sea those methods of competition which Germany has found so helpful, and so successful, in the past.

# APPENDIX TO NAVAL SECTION.

# LIST OF BRITISH AND FOREIGN SHIPS.

The following abbreviations are used throughout the Alphabetical List:—

a.c. Armoured cruiser.
a.g.b. Armoured gunboat.
b. Battleship.
b.c. Battle-cruiser.
l.cr. Light cruiser.
Flot. ldr. Flotilla leader.
c.d.s. Coast-defence ship.
P. L. Cr. Protected light cruiser.
cr. Cruiser.
A.A. Anti-aircraft guns. (H A. = High angle)
g.b. Gunboat.

g.v. Gun-vessel.
H.A. High angle = A.A. Anti-aircraft.
H.N.S. Harvey nickel steel.
H.S. Harveyised or similar hard-faced steel.
K.S. Krupp steel.
p.v. patrol vessel.
*t.* Turret-ship (in class column).
*t.* Speed and H.P. at trials (in speed and H.P. columns).
s.c. Sea-plane carrier.
to.cr. Torpedo-cruiser.
to.g.b. Torpedo-gunboat.

l. Light guns under 15 cwt., including boats' guns.
M. Machine guns.
sub. Submerged torpedo tube.

The following abbreviations are used to distinguish the various types of boilers:—

W.T. Water-tube boilers, where the type is not known.
B. Belleville.
Bl. Blechynden.
B. & W. Babcock and Wilcox.
D'A. D'Allest.

My. Myabara.
N. or Nic. Niclausse.
Nor. Normand.
N.S. Normand-Sigaudy.
T. Thornycroft.
T.S. Thornycroft-Schulz.
$Y^1$. Yarrow small tube.
$Y^2$. Yarrow large tube.

The following abbreviations distinguish types of turbines:—

P.T. Parsons.

C.T. Curtis.
B.C.T. Brown-Curtis.

A reference is now given in the ship tables to the plates in which diagrams of the ships appear.

# GREAT BRITAIN.—Armoured Ships

| Class. | NAME | Displacement. | Length. | Beam. | Draught. | Horse-Power. | Where Built. | Makers of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns | Armament. Torpedo Tubes. | Speed. | Fuel. Coal. / Oil. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons | ft. | ft. | ft. | | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b. | Ajax . . . *Pl. 6.* | 23,000 | 555 | 89 | 27½ | 28,000 B. & W. | Greenock | Scott . P.T. | 1912 | 1913 | 1,937,631* | 12–6 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 12 *4-in.*, 4 *3-pr.* 2 *3-in.* A.A. | 3 | 22 *t* | 900 | 900 |
| b. | Barham . . *Pl. 3.* | 27,500 | 600 | 90½ | 28¾ | 75,000 B. & W. | Clydeb'nk | J. Brown B.C.T. | 1914 | 1915 | .. | 13–6 | 3–1 | 6 | 4–2 | 10 | 6 | 8 *15-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in* A.A. | 4 | 25 | Oil 2800 | 925 |
| b. | Benbow . . *Pl. 4.* | 25,000 | 580 | 90 | 28 | 29,000 B. & W. | Dalmuir . | Beardmore P.T. | 1913 | 1914 | 2,027,115* | 12–8 | 1–2½ | 9–8 | 1–1½ | 10 | 6 | 10 *13·5-in.*, 12 *6-in.*, 4 *3-pr.* 2 *3-in.* A.A. | 4 | 21 | 3250 / 1050 Oil | 828 |
| b. | Centurion . *Pl. 6.* | 23,000 | 555 | 89 | 27½ | 28,200 Y² | Devonp'rt | Hawthorn P.T. | 1911 | 1913 | 1,939,648* | 12–6 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 12 *4-in.*, 4 *3-pr.* 2 *4-in.* A.A. | 3 | 22 *t* | 900 | 900 |
| b. | Conqueror . *Pl. 6.* | 22,500 | 545 | 88½ | 27½ | 29,835 B. & W. | Dalmuir . | Beardmore P.T. | 1911 | 1912 | 1,885,295* | 12 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 14 *4-in.*, 4 *3-pr.*, 1 *3-in.* A.A., 5 M. | 3 | 22·12 | 900 / 2700 | 800 |
| b. | Emperor of India . *Pl. 4.* | 25,000 | 580 | 90 | 28 | 29,000 Y. | Barrow . | Vickers . P. T. | 1913 | 1914 | 2,020,017* | 12–8 | 1–2½ | 9–8 | 1–1½ | 10 | 6 | 10 *13·5-in.*, 12 *6-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 4 | 21 | 3250 / 1050 Oil. | 828 |
| b. | Erin (*ex* Resha-dieh) *Pl. 5.* | 22,940 | 525 | 91½ | 28½ | 26,500 | Barrow . | Vickers . P.T. | 1913 | 1914 | .. | 12–4 K.C. | 3 | 9–8 | 12 | 8 | 10 | 10 *13·5-in.*, 16 *6-in.*, 2 *3-in* A.A., 4 *6-pr.* | 4 (sub.) | 21·5 | 2000 / 700 Oil. | 900 |
| b.c. | Hood . . *Pl. 1.* | 41,200 | 810 | 104 | 28½ | 144,000 | Clydeb'k | J. Brown . | 1918 | 1920 | 5,843,039* | 12–6 | 3–1 | 7–5 | 5–4 | 15–11 | .. | 8 *15-in.*, 12 *5·5-in.*, 4 *4-in.* A.A., 4 *3-pr.* | 4 (deck) 2 (sub.) | 31 | 4000 / 1200 Oil | 1433 |
| b. | Iron Duke . *Pl. 4.* | 25,000 | 580 | 90 | 28 | 29,000 B. & W. | Portsm'th | Cammell Laird P.T. | 1912 | 1914 | 2,080,918 | 12–8 | 1–2½ | 9–8 | 1–1½ | 10 | 6 | 10 *13·5-in.*, 12 *6-in.*, 4 *3-pr.* 2 *3-in.* A.A. | 4 | 21 *t* | 3250 / 1050 Oil | 828 |
| b. | King George V. . *Pl. 6.* | 23,000 | 555 | 89 | 27½ | 28,005 B. & W. | Portsm'th | Parsons . P.T. | 1911 | 1912 | 1,965,413* | 12–6 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 12 *4-in.*, 4 *3-pr.* 2 *3-in.* A.A. | 3 | 22 *t* | 900 | 900 |
| b.c. | Lion . . . *Pl. 11.* | 26,350 | 660 | 88½ | 28 | 75,685 Y² | Devonport | Vickers . P.T. | 1910 | 1912 | 2,086,458* | 9 | .. | 6 | .. | 9 | .. | 8 *13·5-in.*, 15 *4-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 2 | 28·5 *t* | 3000 | 980 |

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b. | **Malaya**¶ *Pl.* 3. | 27,500 | 600 | 90½ | 28¾ | 75,000 B. & W. | Walker | Wallsend P. T. | 1915 | 1916 | .. | 13–6 | 3–1 | 6 | 4–2 | 10 | 6 | 8 *15-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 4 | 25 | Oil 3400 | 925 |
| b. | **Marlborough** *Pl.* 4. | 25,000 | 580 | 90 | 28 | 29,000 Y[2] | Devonport | Hawthorn P.T. | 1912 | 1914 | 2,043,437 | 12–8 | 1–2½ | 9–8 | 1–1½ | 10 | 6 | 10 *13·5-in.*, 12 *6-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 4 | 21 *t* | 3250 1050 Oil | 828 |
| b. | **Monarch** *Pl.* 6. | 22,500 | 545 | 88½ | 27½ | 28,555 Y[2] | Elswick | Hawthorn P. T. | 1911 | 1912 | 1,886,912* | 12 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 14 *4-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 3 | 21·88 *t* | 900 2700 | 800 |
| b.c. | **New Zealand**‡ *Pl.* 12. | 18,800 | 555 | 80 | 26½ | 46,894 B. & W. | Govan | Fairfield P.T. | 1911 | 1912 | (‡) | .. | .. | .. | .. | .. | .. | 8 *12-in.*, 10 *4-in.*, 4 *3-pr.*, 5 M., 1 *4-in.* A.A. | 2 | 25 | 1000 | 780 |
| b. | **Orion** *Pl.* 6. | 22,500 | 545 | 88½ | 27½ | 29,108 B. & W. | Portsm'th | Wallsend P. T. | 1910 | 1911 | 1,918,773* | 12 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 13 *1 in.*, 4 *3-pr.*, 5 M., 1 *3-in.* A.A. | 3 | 21·02 *t* | 900 2700 | 800 |
| b.c. | **Princess Royal** *Pl.* 11. | 26,350 | 660 | 88½ | 28 | 76,510 Y[2] | Barrow | Vickers P.T. | 1911 | 1912 | 2,092,214* | 9 | .. | 6 | .. | 9 | .. | 8 *13·5-in.*, 16 *4-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 2 | 28·5 *t* | 3000 | 980 |
| b | **Queen Elizabeth** *Pl.* 3. | 27,500 | 600 | 90½ | 28¾ | 75,000 B. & W. | Portsm'th | Wallsend P.T. | 1913 | 1915 | .. | 13–6 | 3–1 | 6 | 4–2 | 10 | 6 | 8 *15-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 4 | 25 | Oil 3400 | 925 |
| b | **Ramillies** | 25,750 | 580 | 88½ | 28½ | 40,000 Y. | Dalmuir | Beardmore, P.T. | 1916 | 1917 | .. | 13–6 | 4–1 | 6 | 6–4 | 11 | 6 | 8 *15-in.*, 14 *6-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 4 | 23 | 3420 Oil | 915 |
| b. | **Resolution** *Pl.* 2. | | | | | | Jarrow | Palmer P.T. | 1915 | 1916 | | | | | | | | | | | | |
| b. | **Revenge** | 25,750 | 580 | 88½ | 28½ | 40,000 Y. | Barrow | Vickers P.T. | 1915 | 1916 | .. | 13–6 | 4–1 | 6 | 6–4 | 11 | 6 | 8 *15-in.*, 14 *6-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 4 | 23 | 3420 Oil. | 915 |
| b. | **Royal Oak** | | | | | | Devonp'rt | Hawthorn P.T. | 1914 | 1916 | | | | | | | | | | | | |
| b. | **Royal Sovereign** *Pl.* 2. | | | | | | Portsm'th | Parsons P.T. | 1915 | 1916 | | | | | | | | | | | | |
| b.c. | **Renown** | 26,500 | 750 | 90 | 25½ | 112,000 B. & W. | Govan | Fairfield B.C.T. | 1916 | 1916 | .. | 6–3 K.C. | 2 | 6–3 | 4–3 | 9–7 K.C. | 6 K.C. | 6 *15-in.*, 17 *4-in.*, 4 *3-pr.*, 2 *3-in.* A.A. | 2 | 32 | 4250 Oil. | 950 |
| b.c. | **Repulse** *Pl.* 7. | | | | | | Clydeb'nk | J. Brown B.C.T. | 1916 | 1916 | | | | | | | | | | | | |
| b. | **Thunderer** *Pl.* 6. | 22,500 | 545 | 88½ | 27½ | 27,604 B. & W. | Blackwall | Thames Ironworks P. T. | 1911 | 1912 | 1,889,920* | 12 | .. | 9 | .. | 10 | .. | 10 *13·5-in.*, 14 *4-in.*, 4 *3-pr.*, 1 *3-in.* A.A., 5 M. | 3 | 21 | 900 2700 | 800 |

* Total estimated cost of ship including guns.

‡ Built at the charge of the New Zealand Government.

¶ Built at the charge of the Federated Malay States.

# GREAT BRITAIN.—Armoured Ships—*continued.*

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Horse-Power. | Where Built. | Maker of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns | Armament. Torpedo Tubes. | Speed | Fuel. Coal. / Oil. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | £. | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| *b.c.* | **Tiger.** *Pl.* 10. | 28,500 | 660 | 90½ | 28½ | 108,000 B. & W. | Clydeb'nk | J. Brown B. C. T. | 1913 | 1914 | 2,500,000* | 9–3 | 3–1 | 6 | 4–2 | 9 | 6 | 8 *13·5-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 4 | 30 | 3320 / 900 | 1110 |
| *b.* | **Valiant** *Pl.* 3. | 27,500 | 600 | 90½ | 28¾ | 75,000 B. & W. | Govan | Fairfield B. C. T. | 1914 | 1916 | .. | 13–6 | 3–1 | 6 | 4–2 | 10 | 6 | 8 *15-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 4 | 25 | Oil 3400 | 925 |
| *b.* | **Warspite** *Pl.* 3. | 27,500 | 600 | 90½ | 28¾ | 75,000 B. & W. | Devonp'rt | Hawthorn P.T. | 1913 | 1915 | .. | 13–6 | 3–1 | 6 | 4–2 | 10 | 6 | 8 *15-in.*, 12 *6-in.*, 4 *3-pr.*, 5 M., 2 *3-in.* A.A. | 4 | 25 | Oil 3400 | 925 |
| | Four battle-cruisers (projected.) | Improved Hood design | | | | — | To be built by contract. | | — | — | — | — | — | — | — | — | — | 16-*in.* guns. | — | — | — | — |

* Total estimated cost of ship, including guns.

The following ships are in the non-effective category: Agamemnon, battleship, Fleet target service; Antrim, cruiser, signal and wireless experimental ship.

## River Gunboats.

Two classes of river gunboats have been added to the Navy during the war. The first class has a displacement of 640 tons, length 230 ft., beam 36 ft., draught 4 ft., H.P. 2000, speed 14 knots, armament, two 6-in., two 12-prs., six M.; fuel capacity, coal 35, oil 54 tons. Names:—Aphis, Bee, Cicala, Cockchafer, Cricket, Glowworm, Gnat, Ladybird, Mantis, Moth, Scarab and Tarantula. Particulars of the smaller class are:—Displacement 98 tons, length 120 ft., beam 20 ft., draught 2 ft., H.P. 175, speed 10 knots, armament, one 4-in., one 12-pr., one 2-pr. A.A.; fuel capacity, coal 5, oil, 10 tons. Names:—Firefly, Gadfly, Grayfly, Greenfly, Mayfly, Sedgefly, Blackfly, Caddisfly, and Hoverfly. The Mayfly has been lent to the War Office since January, 1918.

# GREAT BRITAIN.—Cruising Ships, &c.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Horse-Power. | Where Built. | Maker of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Fuel. Coal. Oil. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | £ | in. | in. | | | knots. | tons. | |
| S C. | Argus | 14,450 | 565 | 68 | $22\frac{3}{4}$ | 20,000 | Dalmuir | Beardmore | 1917 | 1918 | .. | .. | .. | 4 *4-in.* A.A., 2 *4-in.* Q.F. | .. | $20\frac{3}{4}$ | .. | .. |
| P. L. Cr. | Inconstant | | | | | | Dalmuir | Beardmore P.T. | 1914 | 1914 | | | | | | | | |
| P. L. Cr. | Galatea | | | | | | Dalmuir | Beardmore P.T. | 1914 | 1914 | | | | | | | | |
| P. L. Cr. | Penelope | 3500 | 410 | 39 | 14 | 40,000 | Barrow | Vickers P.T. | 1914 | 1914 | 289,000* | 3 | .. | 3 *6-in.*, 4 *4-in.* Q.F., 2 *3-in.* A.A., 1 M. | 4 | 30 | 840 Oil. | 270 |
| P. L. Cr. | Phaeton | | | | | | Barrow | Vickers P.T. | 1914 | 1915 | | | | | | | | |
| P. L. Cr. | Royalist | | | | | | Dalmuir | Beardmore P.T. | 1915 | 1915 | | | | | | | | |
| P. L. Cr. | Undaunted | | | | | | Govan | Fairfield B.C.T. | 1914 | 1914 | | | | | | | | |
| Cr. | Birmingham | 5440 | 430 | 49·10 | 15·10 | 26,500 | Elswick | Hawthorn | 1912 | 1914 | 353,437* | .. | .. | 9 *6-in.*, 4 *3-pr.*, 1 *3-in.* A.A. | 2 | 25·5 | 650 | 400 |
| L. Cr. | Courageous | 18,600 | 735 | 81 | 22·3 | 90,000 Y. | Walker (Armstr'g) | Parsons | 1916 | 1916 | .. | 3 | 9–7 | 4 *15-in.*, 18 *4-in.*, 2 *3-in.* A.A., 5 M. | 2 / 12 | 32 | Oil / 3250 | 785 |
| „ | Glorious *Pl.* 8. | | | | | | Belfast | Harland & Wolff | | | | | | | | | | |
| S. C. | Furious *Pl.* 9. | 19,100 | 735 | 88 | 21·6 | 90,000 | Walker (Armstrong) | Wallsend Engn'g Co. | 1916 | 1917 | 1,920,000† | 3 | 7 | 10 *5·5-in.*, 5 *3-in.* A.A., 2 *3-pr.* | 2 / 16 | 31 | Oil / 3400 | 725 |

## GREAT BRITAIN.—Cruising Ships, &c.—*continued.*

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Horse-Power. | Where Built. | Maker of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. / Deck. | Armour. Gun Position | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Fuel. Coal. / Oil. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | £ | in. | in. | | | knots. | tons. | |
| P. L. Cr. | Calliope | | | | | | Chath'm | Parsons P.T. | 1914 | 1915 | | | | | | | | |
| ,, ,, | Caroline | | | | | | Birken-head | Cammell Laird P.T. | 1914 | 1914 | | | | | | | | |
| ,, ,, | Carysfort | | | | | | Pembroke | Hawthorn. B.C.T. | 1914 | 1915 | | | | | | | | |
| ,, ,, | Champion | | | | | | Newcastle (Hawth'rn) | Hawthorn. P.T. | 1914 | 1915 | | | | | | | | |
| ,, ,, | Cleopatra | 3750 | 420 | 41 | 13·6 | 40,000 | Devonport | Cammell Laird P.T. | 1914 | 1915 | .. | 3 | .. | 2 6-*in.*, 8 4-*in.*, 2 3-*in.*, A.A. ‡ | 4 | 29 | Oil 900 | 287 |
| ,, ,, | Comus | | | | | | Newcastle (Swan Hunter) | Wallsend Engn'g Co. P.T. | 1914 | 1915 | | | | | | | | |
| ,, ,, | Conquest | | | | | | Chatham | Scotts' P.T. | 1914 | 1915 | | | | | | | | |
| ,, ,, | Cordelia *Pl.* 16. | | | | | | Pembroke | Hawthorn. P.T. | 1914 | 1915 | .. | 3 | .. | 2 6-*in.*, 8 4-*in.*, 2 3-*in.*, A.A. ‡ | .. | 29 | Oil 900 | 287 |
| ,, ,, | Cairo | | | | | | Birken-head | Cammell Laird | 1918 | 1919 | | | | | | | | |
| ,, ,, | Calcutta | | | | | | Barrow | Vickers | 1918 | 1919 | | | | | | | | |
| ,, ,, | Cape Town | 4190 | 425 | 43·6 | 14·6 | 40,000 | Birken-head | Cammell Laird | 1919 | 1921 | .. | 3 | .. | 5 6-*in.*, 2 3-*in.* A.A. | 8 | 29 | Oil 900 | 287 |
| ,, ,, | Carlisle | | | | | | Govan | Fairfield | 1918 | 1918 | | | | | | | | |
| ,, ,, | Colombo *Pl.* 16. | | | | | | Govan | Fairfield | 1918 | 1919 | | | | | | | | |
| ,, ,, | Caledon | | | | | | Birken-head | Cammell Laird | 1916 | | | | | | | | | |
| ,, ,, | Calypso | 4120 | 425 | 42·9 | 14·6 | 40,000 | Glasgow | Scotts' | 1917 | 1917 | 300,000 | 3 | .. | 5 6-*in.*, 2 3-*in.* A.A. | 8 | 29 | Oil 900 | 287 |
| ,, ,, | Caradoc *Pl.* 16. | | | | | | Barrow | Vickers | 1916 | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P. L. Cr. | Cambrian | 3750 | 420 | 41·6 | 14·6 | 40,000 | Pembroke | .. | 1915 | 1916 | 300,000† | 3 | .. | 5 *6-in.*, 2 *3-in.* A.A. | 4 | 29 | Oil / 900 | 287 |
| „ „ | Canterbury | | | | | | Clydebank | J. Brown | 1915 | 1916 | | | | | | | | |
| „ „ | Castor | | | | | | Birkenhead | Cammell Laird | 1915 | 1915 | | | | | | | | |
| „ „ | Constance *Pl.* 16. | | | | | | Birkenhead | Cammell Laird | 1915 | 1916 | | | | | | | | |
| „ „ | Cardiff | 4190 | 425 | 43·6 | 14·6 | 40,000 | Govan | Fairfield | 1917 | 1917 | .. | 3 | .. | 5 *6-in.*, 2 *3-in.* A.A. | 8 | 29 | Oil / 900 | 287 |
| „ „ | Ceres | | | | | | Clydebank | J. Brown | 1917 | 1917 | | | | | | | | |
| „ „ | Coventry | | | | | | Newcastle (Swan Hunter) | Swan Hunter | 1917 | 1918 | | | | | | | | |
| „ „ | Curacoa | | | | | | Pembroke | .. | 1917 | 1918 | | | | | | | | |
| „ „ | Curlew *Pl.* 16. | | | | | | Barrow | Vickers | 1917 | 1917 | | | | | | | | |
| „ „ | Centaur | 3750 | 420 | 42 | 13·6 | 40,000 | Elswick | Armstrong | 1915 | 1916 | 300,000† | 3 | .. | 5 *6-in.* | 4 | 29 | Oil / 900 | 287 |
| „ „ | Concord *Pl.* 16. | | | | | | Elswick | Armstrong | | | | | | | | | | |
| Cr. | Dartmouth | 5250 | 430 | 48½ | 15½ | 23,467 Y. | Barrow | Vickers P.T. | 1911 | 1911 | 329,406* | 2–¾ | .. | 8 *6-in.*, 4 *3-pr.*, 4 M., 1 *3-in.* A.A. | 2 | 25·9 *t* | 1290 / 260 | 390 |
| P. L. Cr. | Despatch | 4750 | 445 | 46 | 14·3 | 40,000 | Govan | Fairfield | 1919 | .. | .. | 3 | Shields | 6 *6-in.*, 2 *3-in.* A.A. | 12 | 29 | Oil / 1050 | 340 |
| „ „ | Diomede *Pl.* 15. | | | | | | Barrow | Vickers | 1919 | .. | | | | | | | | |
| „ „ | Danae | 4750 | 445 | 46 | 14·3 | 40,000 | Elswick | Armstrong | 1918 | 1918 | .. | 3 | Shields | 6 *6-in.*, 2 *3-in.* A.A. | 12 | 29 | Oil / 1050 | 340 |
| „ „ | Dauntless | | | | | | Jarrow | Palmer | 1918 | 1918 | | | | | | | | |
| „ „ | Dragon *Pl.* 15. | | | | | | Green'ck | Scott | 1917 | 1918 | | | | | | | | |

* Total estimated cost of ship including guns. † Estimated cost as originally designed. ‡ Some of the vessels of this class have all 6-in. armament; and the anti-aircraft guns also vary.

# GREAT BRITAIN.—Cruising Ships, &c.—*continued.*

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Maker of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. / Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Fuel. Coal. Oil. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | £ | in. | in. | | | knots. | tons. | |
| P. L. Cr. | Delhi | | | | | | Elswick | Armstrong | 1918 | 1919 | | | | | | | | |
| „ „ | Dunedin | 4750 | 445 | 46 | 14·3 | 40,000 | Elswick | Armstrong | 1918 | 1919 | .. | 3 | Shields | 6 *6-in*, 2 *3-in.* A.A. | 12 | 29 | Oil 1050 | 340 |
| „ „ | Durban *Pl.* 15. | | | | | | Green'ck | Scott | 1919 | 1921 | | | | | | | | |
| Cr. | Dublin | 5400 | 430 | 49·10 | 15¾ | 25,000 Y. | Dalmuir | Beardmore P. T. | 1912 | 1913 | 337,565* | 3 / — | .. | 8 *6-in.*, 1 *3-in.* A.A., 4 *3-pr.*, 4 M., 1 l. | 2 | 25·5 | 1240 260 | 400 |
| S.C. | Eagle, *ex* Almirante Cochrane. | 22,790 | 625 | 92 | 24 | 55,000 | Walker | J. Brown | 1918 | 1920 | 3,310,042 | .. | .. | .. | .. | 24 | .. | .. |
| P. L. Cr. | Effingham | | | | | | Portsmouth | Harland & Wolff | 1921 | .. | | | | | | | | |
| „ „ | Frobisher | | | | | | Devonport | Wallsend Eng'g Co. | 1920 | .. | | | | | | | | |
| „ „ | Hawkins | 9750 | 565 | 65 | 17·3 | 60,000 70,000 | Chatham | Parsons Co. | .. | 1919 | 750,000† | 3 | Shields | 7 *7·5-in.*, 6 *3-in.*, Q.F., 4 *3-in.*, A.A. | 6 | 30 | 1500 800 Oil | 480 |
| „ „ | Raleigh *Pl.* 13. | | | | | | Dalmuir | Beardmore | 1919 | 1920 | | | | | | | | |
| P. L. Cr. | Enterprise | 7550 | 545 | 54½ | 16½ | 80,000 | Clydebank | John Brown | 1919 | .. | .. | 3–1½ / 1 | .. | 7 *6-in.*, 2 *4-in.* A.A. | 12 | 32·33 | 1600 650 Oil | 556 |
| „ „ | Emerald | | | | | | Elswick | Armstrong | 1920 | .. | .. | | | | | | | |
| S. C. | Hermes | 10,400 | 548 | 70 | 18¾ | 40,000 | Elswick | Parsons Co. | 1919 | .. | .. | .. | .. | 10 *5·5-in.*, 4 *4-in.* A.A. | .. | 25 | 2000 | 630 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cr. . . . | **Lowestoft** . . | 5440 | 430 | 49 | 15 | 22,000 | Chatham | Fairfield . | 1913 | 1914 | 375,162 | .. | .. | 9 *6-in.*, 4 *3-pr.*, 1 *3-in.*, A.A. | 2 | 25·5 | 650 | .. |
| S. C. . . | **Pegasus** . . (late Stockholm) | 3070 | .. | .. | .. | 9,500 † | .. | 1917 | .. | .. | .. | .. | .. | 4 *12-pr.*, 2 A.A. | .. | .. | .. | .. |
| Minelayer . | **Princess Margaret** . | 5070 | 395½ | 54 | 16½ | 15,000 | Purchased 1919 | .. | .. | 1914 | .. | .. | .. | 2 *4·7-in.*, 2 *12-pr.*, 2 *6-pr.*, A A. | .. | 22½ | 585 | .. |
| Cr. . . . | **Southampton** . | 5400 | 430 | 49·10 | 15¾ | 25,000 Y. | Clydeb'nk | J. Brown . C.T. | 1912 | 1913 | 336,469* | 3 | .. | 8 *6-in.*, 4 *3-pr.*, 4 M., 1 *3-in.* A.A. | 2 | 25·5 | 1240<br>260 | 400 |
| S. C. . . | **Vindictive** . *ex* Cavendish *Pl.* 14. | 9750 | 565 | 65 | 20·4 | 60,000 | Belfast | Harland & Wolff | .. | 1918 | .. | .. | .. | 4 *7·5 in.*, 4 *3-in.*, Q.F., 4 *3-in.*, A.A. | 6 | 28·75 | 800<br>1420 | .. |
| " . . . .<br>" . . . . | **Weymouth**<br>**Yarmouth** | 5250 | 430 | 48½ | 15½ | 22,000 Y. | Elswick<br>Glasgow | Parsons . P. T.<br>London & Glas. Co. C. T. | 1910<br>1911 | 1911<br>1912 | 337,738*<br>353,238* | 2¾ | .. | 8 *6-in.*, 4 *3-pr.*, 4 M., 1 *3-in.* A A. | 2 | 25·5 † | 1290<br>260 | 390 |

* Total estimated cost of ship, including guns.  † Estimated cost as originally designed.  § 500 Naval ratings, and 130 R.A.F. Personnel

There are a number of other vessels on the effective list which are being used for various purposes as repair ships, and other auxiliary work, including depôt ships for destroyers and submarines.

# Defence Forces of the Dominions.

## ROYAL AUSTRALIAN NAVY.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Maker of Engines. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. / Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | £ | in. | in. | | | knots. | tons. | |
| *b.c.* | Australia . *Pl.* 12. | 18,800 | 555 | 80 | 26½ | 48,000 | Clyde-bank | J. Brown . P.T. | 1911 | 1913 | .. | .. | .. | 8 *12-in.*, 12 *4-in.*, 2 *4-in.* A.A., 4 *3-pr.*, 5 M. | 2 | 26·0 *t* | 1000 | 790 |
| P. L. Cr. | Adelaide . | 5560 | 430 | 49½ | 15¾ | 25,000 | Sydney | .. | 1918 | .. | .. | .. | .. | 9 *6-in.*, 1 *12-pr.*, 4 *3-pr.*, 1 *3-in.* A.A. | 2 | 26 | .. | .. |
| ” ” | Melbourne | 5400 | 430 | 49½ | 15¾ | 25,000 | Birken-head | Cammell Laird | 1912 | 1913 | .. | .. | .. | 8 *6-in.*, 4 *3-pr.*, 4 M., 1 *3-in.* A A. | 2 | 25·5 | .. | .. |
| ” ” | Sydney | | | | | | Glasgow | London & Glasgow Co. | 1912 | 1913 | | | | | | | | |
| ” ” | Brisbane | | | | | | Sydney | .. | 1915 | 1916 | | | | | | | | |
| ” ” | Encounter | 5880 | 355 | 56 | 20¼ | 12,500 Dürr | Devonp'rt | Devonport Dockyard . | 1903 | 1906 | 370,275 | 3-2 | .. | 11 *6-in.*, 9 *12-pr.*, 1 *3-pr.*, 2 M. | 2 | 20·75 | 600 | 454 |
| Flot. Ldr. | Anzac | 1660 | 315 | 31·9 | 10 | 36,000 | Dumbar-ton | Denny . | 1916 | 1917 | .. | .. | .. | 4 *4-in.*, Q.F., 2 *2-pr.* | 4 | 34 | 515 Oil | .. |

DESTROYERS.—"*River*" *Class*:—Huon, Parramatta, Swan, Torrens, Warrego, Yarra. Launched, 1910-15; Displacement, 700 tons; 9,500-11,300 H.P.; speed, 27 knots; armament, one 4-in., three 12-pdrs., three tubes.

"*S*" *Class*:—Stalwart, Success, Swordsman, Tasmania, Tattoo. Launched, 1918–19; Displacement, 1,250 tons; 27,00 H.P.; speed, 36 knots; armament, three 4-in., one 2-pdr., 6 tubes (4 21-in., 2 18-in.).

SUBMARINES.—"*J*" *Class*:—J 1, J 2, J 3, J 4, J 5, J 7. Launched, 1916–18; Displacement, surface, 1,210 tons, submerged, 1,820 tons; H.P., surface, 3,600, submerged, 1,350; speed, surface, 19 knots, submerged, 9½ knots; oil fuel, 91 tons; armament, one 3-in. or 4-in., six 18-in. tubes.

SLOOPS.—"*Flower*" *Class*:—Mallow, Marguerite, Geranium. Launched, 1915; Displacement, 1,250 tons; 2,000 H.P.; speed, 17 knots; armament, one 4·7-in., two 3-pr. A.A.

The Royal Australian Navy also includes the Cerberus and Una, gunboats; Platypus, submarine depôt ship; Pioneer, light cruiser, and several old cruisers and sloops which were lent for service during the war, as well as certain armed patrol vessels taken up for the same purpose.

## NEW ZEALAND NAVY.

Light Cruiser.—"*City*" *Class* :—Chatham. Completed, 1912 (Chatham Dockyard and Thames Ironworks). Displacement, 5,400 tons; 25,000 H.P.; speed, 25½ knots; armament, eight 6-in., four 3-pr., one 3-in. A.A., four M., two 21-in. tubes; max. coal, 1,240 tons; oil, 260 tons; complement, 400.

Ex-Light Cruiser.—"*Pearl*" *Class* :—Philomel. (Training and Depot-ship, Auckland). Completed, 1892 (Devonport and Earle). Displacement, 2,575 tons; 7,500 H.P.; speed 19 knots: armament, one 6-in., one 4-in., two 12-pr.; coal, 300 tons; original complement, 217.

## NEWFOUNDLAND.

Sloop.—"*Flower*" *Class* :—Lobelia. Completed 1916 (Simons). Displacement, 1,250 tons; 2,000 H.P.; speed, 17 knots; armament, one 4·7-in., two 3-pr. A.A.

## ROYAL CANADIAN NAVY.

Light Cruiser.—"*Arethusa*" *Class* :—Aurora. Completed, 1914 (Devonport Dockyard and Parsons Co.). Displacement, 3,500 tons; 40,000 H.P.; speed, 30 knots; armament, two 6-in., six 4-in. Q.F., one 4-in. A.A., one M., four 21-in. tubes; oil, 840 tons; complement, 270.

Destroyers.—"*M*" *Class* :—Patrician and Patriot. Completed, 1916 (Thornycroft). Displacement, 980 tons; 26,500 H.P.; speed, 35 knots; armament, three 4-in., two 1½-pdrs., four 21-in. tubes; oil, 256 tons (radius of action, 1,510 at 15 knots).

Submarines.—"*H*" *Class* :—H 4, H 15. Surface displacement, 440 tons, submerged, 500; surface H.P., 480, submerged, 320; surface speed, 13 knots, submerged, 10½ knots; oil fuel, 16 tons; armament, four 21-in. tubes.

The Royal Canadian Navy has no effective ships of the larger classes, the cruisers Niobe and Rainbow, which were lent for training purposes, being ordered in March, 1920, to be paid off for sale. There are other small craft used for miscellaneous and special service during the war.

## SOUTH AFRICA.

Surveying Ship.—"*Beaufort*" *Class* :—Crozier. Twin-screw mine-sweeper, converted 1919. Displacement, 800 tons; 2,200 H.P.; speed, 16 knots; coal capacity, 181–185 tons; armament, one 3-pr. Transferred to South Africa, September, 1921.

Trawlers.—*Admiralty Type* :—Eden and Foyle. Armament, one 12-pr. Transferred to South Africa, September, 1921, for mine-sweeping instructional duties.

# ARGENTINE REPUBLIC.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| *a.c.* | **Garibaldi** . . | 6732 | 328 | 59¾ | 24 | 13,384 | Sestri Ponente | 1895 | 1896 | 752,000 | 6–3 H.S. | 1½ | 6 H.S. | 6 H.S. | 6 H.S. | 6 H.S. | 2 *10-in.*, 10 *6-in.*, 6 *4·7-in.*, 4 *2·2-in.*, 2 M. | 2 | 19·9 *t* | 1000 | 500 |
| *a.c.* | **General Belgrano** . | 7069 | 328 | 59¾ | 24 | 13,000 | Leghorn . | 1897 | 1899 | 696,700 | 6–3 H.S. | 1½ | 6 H.S. | 6 H.S. | 6 H.S. | 6 H.S. | 2 *10-in.*, 14 *6-in.*, 2 *3-in.*, 4 *2·2-in.*, 2 L., 2 M. | 4 | 20·1 *t* | 1000 | 500 |
| *a.c.* | **General San Martin** | 6773 | 328 | 59¾ | 24 | 13,000 | Leghorn . | 1896 | 1898 | 688,200 | 6–3 H.S. | 1½ | 6 H.S. | 6 H.S. | 6 H.S. | 6 H.S. | 4 *8-in.*, 10 *6-in.*, 6 *4·7-in.*, 4 *2·2-in.*, 2 L., 2 M. | 4 | 19·8 | 1100 | 500 |
| *b.* | { **Moreno** . . <br> **Rivadavia** . *Pl.* 17. } | 27600 | 585 | 98 | 27½ | { 39,500 B. & W. Curtis t. } | { Camden, N.J. (N.Y.S.B.Co.) Quincy, Mass. } | 1911 | 1914 | 2,200,000 | 12–10 K.S. | 3–2 | 9–6 K.S. | 9 K.S. | 12–9 K.S. | 6 K.S. | 12 *12-in.*, 12 *6-in.*, 16 *4-in.*, 10 smaller. | 2 sub. | 22·5 *t* | 1600 4000 | 1046 |
| *a.c.* | **Pueyrredon** . . | 6773 | 328 | 59¾ | 24 | 13,000 B. | Sestri Ponente | 1898 | 1901 | 782,000 | 6–3 H.S. | 1½ | 6 H.S. | 5 H.S. | 6 H.S. | 6 H.S. | 2 *10-in.*, 10 *6-in.*, 6 *4·7-in.*, 4 *2·2-in.*, 2 M. | 4 | 20·1 *t* | 1000 | 500 |

The old coast-defence ironclads Libertad and Independencia, 2336 tons, completed at Birkenhead in 1892–93, carry two 9·4-in., four 4·7-in., and four 3-pr. guns.
Cruiser Buenos Aires (Elswick, 1895), 4780 tons, two 8-in., four 6-in., six 4·7 in., three T.T., 23·2 knots on trial; river gunboats Patria (1894), 1070 tons, two 4·7 in., eight smaller, five T.T., Paraná and Rosario (Elswick, 1909), 1000 tons, two 6-in. howitzers, six 12-pr., twelve smaller, 15 knots. For destroyers, see Flotilla Tables.
**The training-ship (cruiser)** Presidente Sarmiento, 2750 tons; also the old cruiser Nueve de Julio, 3570 tons, Elswick 1902, and several small gunboats and torpedo-gunboats.
A programme is in contemplation for considerable reorganisation and the augmentation of the resources of the Navy.

## BRAZIL.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkheads. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in | | | knots. | tons. | |
| c.d.s., t. | **Marshal Deodoro** | 3112 | 267½ | 48 | 13½ | 3400 D'A. | La Seyne | 1898 | 1900 | .. | 13¾–4 H.S. | 1½ | .. | .. | 8 H.S. | 3 H.S. | 2 *9·4-in.*, 4 *4·7-in.*, 2 M., 4 *6-pr.*, 2 *1-pr.* | 2 (sub.) | 15·0 | 236 | 200 |
| c.d.s., t. | **Marshal Floriano** | | | | | | | 1899 | 1901 | | | | | | | | | | | | |
| b. | **Minas Geraes** . *Pl.* 18. | 19,281 | 500 | 83 | 25 | 27,212 *t* B.&W. | Elswick | . 1908 | 1909 | 1,821,400 | 9–6–4 K.S. | 2 | 9–6–4 K.S. | 9 | 12–8 K.S. | 9 K.S. | 12 *12-in.*, 22 *4·7-in.*, 8 *3-pr.* | 4 | 21·4 *t* | 900 2400 | 900 |
| b. | **São Paulo** . *Pl.* 18. | 19,281 | 500 | 83 | 25 | 28,645 *t* B.&W. | Barrow | . 1909 | 1910 | 1,821,400 | 9–6–4 K.S. | 2 | 9–6–4 K.S. | 9 K.S. | 12–8 K.S. | 9 K.S. | 12 *12-in.*, 22 *4·7-in.*, 8 *3-pr.* | 4 | 21·6 *t* | 900 2400 | 900 |

Also river monitors Maranhao and Pernambuco, built at Rio de Janeiro.

Light Cruisers:—Bahia and Rio Grande do Sul, completed at Elswick, 1910, 3100 tons, ten 4·7-in., eight 1·8-in. guns, 17,000 H.P., 27 knots; Barroso (Elswick, 1897), 3600 tons, six 6-in., four 4·7-in. guns, 20 knots. Four 12-knot river gunboats, Missões, Acre and two others (Poplar, 1907). Carlos Gomes, mine-layer.

# CHILE.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | kts. | tons. | |
| b | Almirante Latorre (ex Canada) *Pl. 19.* | 28,000 | 625 | 92 | 28½ | 37,000 Y 2 | Elswick | 1913 | 1915 | .. | 9–4 A.I. | 4–2½ | 4½ | .. | 10 | 6 | 10 *14-in.*, 14 *6-in.*, 6 *3-in.* and M. | 4 sub. | 23 | 3300 / 520 | 1000 |
| a.c. | O'Higgins | 8,500 | 411¾ | 62½ | 22 | 16,000 B. | Elswick | 1897 | 1898 | .. | 7–5 | 2 | .. | .. | 7½–6 | 6 | 4 *8-in.*, 10 *6-in.*, 4 *4·7-in.*, 10 *12-pr.*, 10 *6-pr.*, 4 M. | 3 (2 sub.) | 21·5 t | 1260 | 500 |
| b. | Capitan Prat | 5,981 | 328 | 60¾ | 21¾ | 12,000 | La Seyne | 1890 | 1893 | 391,000 | 12 | 3 | 4 | .. | 10½ | 2 | 4 *9·4-in.* (Canet), 8 *4·7-in.* (Canet), 10 *12-pr.*, 14 smaller and M. | 4 | 18·3 t | 775 | 480 |
| a.c. | Esmeralda | 7,020 | 436 | 53¼ | 22¼ | 16,000 | Elswick | 1896 | 1897 | .. | 6 H.S. | 2 | .. | 6 H.S. | 4½ Shields | .. | 2 *8-in.*, 16 *6-in.*, 8 *12-pr.*, 2 *3-pr.*, 4 M. | 3 | 22·8 t | 1350 | 500 |

Capitan Prat reconstructed.

# Cruising Ships, &c.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | in. | in. | | | knots. | tons. | |
| cr. | **Blanco Encalada** | 4400 | 370 | 46½ | 18½ | 14,500 | Elswick | 1893 | 1894 | .. | 4–1¾ | .. | 2 *8-in.*, 10 *6-in.*, 12 *3-pr.*, 10 *1-pr.** | 5 | 22·78 t | 900 | 427 |
| „ | **Chacabuco** | 4500 | 360 | 46 | 18 | 15,750 | Elswick | 1901 | 1903 | .. | 4½–1¾ | .. | 2 *8-in.*, 10 *4·7-in.*, 16 *1·8-in.*, 2 M., 1 l. | 5 | 23·0 | 1000 | 350 |
| „ | **General Baquedano** (Training) | 2330 | 240 | 45¾ | 18 | 1500 B. | Elswick | 1898 | 1900 | .. | .. | .. | 4 *4·7-in.*, 2 *12-pr.*, 2 *6-pr.*, 2 M., 1 l. | 1 | 13·7 t. | 300 | 302 |
| „ | **Ministro Zenteno** | 3600 | 330¼ | 43¾ | 16¾ | 6500 | Elswick | 1896 | 1898 | .. | .. | .. | 8 *6-in.*, 10 *6-pr.*, 4 *1-pr.** | 3 | 20·0t | 800 | 280 |
| „ | **Presidente Errázuriz** | 2047 | 268 | 35¾ | 19½ | 5400 | La Seyne | 1890 | 1892 | .. | 3½ | .. | 4 *6-in.* (Canet), 2 *5-in.*, 4 *2·2-in.*, 6 M. | 3 | 19·0 | 200 | 171 |

* Armstrong.

**Transports**: Maipo, 11,000 tons; Rancagua, 10,000 tons; Angamos, 5,000 tons; Aguila, 600 tons; Porvenir, 300 tons. Sloops or patrol vessels: Orompello, Leucoton, Elicura, Colocolo, 500 tons; Yaucz, Yelcho, Huemul, Condor, 100 to 250 tons.

# DENMARK.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed | Fuel. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| c.d.s.,t. | **Herluf Trolle** | 3595 | 271 | 50 | 16¼ | 4400 T. | Copenhagen | 1899 | 1901 | .. | 7–4 H.S. | 3 | .. | .. | 7 H.S. | 6 H.S. | 2 *9·4-in.*, 4 *5·9-in.*, 6 *12-pr.*, 2 *6-pr.* | 3 (sub.) | 16·5 | 250 | 250 |
| c.d.s.,t. | **Niels Juel** | 4100 | 295 | 53½ | 15¾ | 5500 | Copenhagen | 1918 | 1921 | .. | 7–4 K.S. | 2 | .. | 7 | .. | 10 K.S. | 10 *5·9-in.*, 3 *6-pr.* | 2 (sub.) | 17 | Oil | 250 |
| c.d.s.,t. | **Olfert Fischer** | 3650 | 271 | 50 | 16¼ | 4600 | Copenhagen | 1903 | 1905 | .. | 7–4 K.S. | 3 | .. | .. | 7 K.S. | 6 | 2 *9·4-in.*, 4 *5·9-in.*, 6 *12-pr.*, 2 *6-pr.* | 3 (sub.) | 16·0 | 250 | 250 |
| c.d.s.,t. | **Peder Skram** | 3735 | 274½ | 51½ | 16¼ | 5400 | Copenhagen | 1908 | 1909 | .. | 8–4 K.S. | 2 | .. | .. | 7 K.S. | 6 K.S. | 2 *9·4-in.*, 4 *5·9-in.*, 10 *14-pr.*, 2 *1-pr.* | 4 | 16·0 | 250 | 250 |
| c.d.s.,t. | **Skjold** | 2200 | 226½ | 38 | 13½ | 2400 T. | Copenhagen | 1896 | 1899 | .. | 10–3 H.S. | 2 | .. | 7 | 8 | 5½ | 1 *9·4-in.*, 3 *4·7-in.* (K.), 4 *6-pr.* | 4 | 13·0 | 280 | 210 |

# Cruising Ships, &c.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | | tons. | |
| 3r cl. *cr.* | Geiser | 1280 | 232 | 34 | 11¼ | 3600 T. | Copenhagen | 1892 | 1893 1907 | .. | 1½ | .. | 2 *4·7-in.*, 4 *20-pr.*, 4 *6-pr.* | 2 | 17·1 *t* | 150 | 155 |
| ,, | Heimdal | 1313 | 232 | 34 | 11¾ | 3100 T. | Copenhagen | 1894 | 1896 | .. | 1½ | .. | 2 *4·7-in.*, 4 *20-pr.*, 4 *6-pr.*, 6 M. | 2 | 17·5 | 150 | 155 |

Heimdal, used as officers' training ship. Valkyrien (3020 tons), reconstructed 1913, training ship. Mine-layers Lossen, Hjalperen, Beskytteren, Minekran V., Minekran VI. Fylla (ex-British sloop Asphodel), and 4 other fishery inspection cruisers. Groensund, submarine repair ship, Hekla submarine depôt. Three surveying ships.

# FRANCE.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. | | | | | | Armament. | | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | Gun Position. | | | | | | |
| | | | | | | | | | | | Belt. | Deck. | Side above Belt. | Bulkhead. | Heavy Guns. | Secondary. | Guns. | Torpedo Tubes. | | | |
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b. | Bretagne . *Pl.* 20. | 23,177 | 546 | 88½ | 29 | 29,000 tur. | Brest . | 1913 | 1915 | 2,589,439 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 10 *13·4-in.*, 18 *5·5-in.*, 8 small Q.F. and M. | 4 (sub.) | 20·0 | 900 2700 | 1167 |
| a.c | Condé * . | 10,397 | 453 | 63¾ | 24½ | 22,175 Nic. | Lorient . | 1902 | 1904 | 863,799 | 6–4 H.S. | 2 | 5–2 H.S. | .. | 7½ H.S. | 6½–5 H.S. | 2 *7·6-in.*, 8 *6·4-in.*, 6 *3·9-in.*, 20 *1·8-in.* | 2 (sub.) | 21·4 *t* | 970 1590 | 615 |
| b. | Condorcet. | 18,890 | 481 | 84 | 27 | 22,500 N. tur. | St. Nazaire | 1909 | 1911 | 2,165,200 | 10–8 K.S. | 2¾ | 8¾ | .. | 12 K.S. | 8¾ K.S. | 4 *12-in.*, 12 *9·4-in.*, 16 *12-pr.*, 8 *3-pr.*, 2 *1-pr.* | 2 (sub.) | 19·8 *t* | 960 2010 | 690 |
| b. | Courbet . *Pl.* 21. | 23,100 | 546 | 88½ | 29 | 28,000 N. tur. | Lorient . | 1911 | 1913 | 2,508,388 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 12 *12-in.*, 22 *5·5-in.*, 4 *3-pr.* 4 L. | 4 (sub.) | 20·0 | 900 2700 | 998 |
| b. | Diderot . | 18,863 | 476 | 84 | 27 | 22,500 N. tur. | St. Nazaire | 1909 | 1911 | 2,167,000 | 10–8 K.S. | 2¾ | 8¾ | .. | 12 K.S. | 8¾ | 4 *12-in.*, 12 *9·4-in.*, 16 *12-pr.*, 8 *3-pr.*, 2 *1-pr.* | 2 (sub.) | 19·75 *t* | 960 2010 | 690 |
| a.c. | Edgar Quinet . | 14,100 | 521 | 70¼ | 27½ | 39,803 *t* B. | Brest . | 1907 | 1911 | 1,307,536 | 6½–3½ K.S. | 2½–1¼ | 5–2 K.S. | 4¾ K.S. | 8 K.S. | 4¾ K.S. | 14 *7·6-in.*, 20 *2·4-in.*, 4 smaller. | 2 (sub.) | 23·9 *t* | 1242 2300 | 738 |
| a.c. | Ernest Renan . *Pl.* 22. | 13,427 | 515 | 70½ | 26¾ | 37,500 Nic., *t* | St. Nazaire | 1906 | 1909 | 1,410,000 | 6¾–4 H.S. | 2 | 5–3 H.S. | 4¾ | 6 H.S. | 5 H.S. | 4 *7·6-in.*, 12 *6·4-in.*, 16 *9-pr.*, 8 *3-pr.* | 2 (sub.) | 25·5 *t* | 1354 2300 | 674 |
| b. | France . *Pl.* 21. | 23,100 | 546 | 88½ | 29 | 28,000 N. tur. | St. Nazaire | 1912 | 1916 | 2,603,920 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 12 *12-in.*, 22 *5·5-in.*, 4 *3-pr.* Q.F. and M. | 4 (sub.) | 20·0 | 900 2700 | 998 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *b.* | **Jean Bart** *Pl.* 21. | 23,467 | 546 | 88½ | 29 | 28,000 B. tur. | Brest | 1911 | 1913 | 2,528,888 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 12 *12-in.*, 22 *5·5-in.*, 4 *3-pr.* | 4 (sub.) | 22·0 | 900 / 2700 | 998 |
| *a.c.* | **Jules Ferry** *Pl.* 22. | 12,351 | 487 | 70¼ | 27 | 30,500 Guyot | Cherbourg | 1903 | 1906 | 1,169,940 | 6¾–4 H.S. | 2 | 5–3 H.S. | 6 | 6 H.S. | 5 H.S. | 4 *7·6-in.*, 16 *6·4-in.*, 16 *9-pr.*, 8 *3-pr.* | 2 (sub.) | 22·8 *t* | 1320 / 2100 | 728 |
| ,, | **Jules Michelet** *Pl.* 22. | 13,370 | 489⅓ | 70¼ | 27 | 27,700 Guyot | Lorient | 1905 | 1908 | 1,204,107 | 6–4 K.S. | 2 | 5–3 K.S. | 6 H.S. | 8 K.S. | 5 K.S. | 4 *7·6-in.*, 12 *6·4-in.*, 2 *9-pr.* | 2 (sub.) | 23·2 *t* | 1320 / 2100 | 724 |
| *b.* | **Lorraine** *Pl.* 20. | 23,549 | 546 | 88½ | 29 | 29,000 tur. S. & cyl. | St. Nazaire | 1913 | 1916 | 2,642,439 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 10 *13·4-in.*, 18 *5·5-in.*, 4 *3-pr.*, 2 *1-pr.* | 4 (sub.) | 20·0 | 900 / 2700 | 1167 |
| *a.c.* | **Marseillaise** * | 9611 | 460 | 66 | 25½ | 21,500 B. | Brest | 1900 | 1903 | 881,270 | 6 4 H.S. | 2 | 5–2 H.S. | .. | 7½ H.S. | 6½–5 H.S. | 2 *7·6-in.*, 8 *6·4-in.*, 6 *3·9-in.*, 2 *2·5-in.*, 20 *1·8-in.* | 2 (sub.) | 21·0 | 970 / 1590 | 615 |
| *a.c.* | **Montcalm** * | 9367 | 459 | 63¾ | 24½ | 19,600 N.S. | La Seyne | 1900 | 1902 | 902,809 | 6 H.S. | 2 | 3¾ H.S. | 6 H.S. | 6 H.S. | 2¾ H.S. | 2 *7·6-in.*, 8 *6·4-in.*, 4 *3·9-in.*, 22 l. | 2 (sub.) | 21·0 | 1020 / 1600 | 612 |
| *b.* | **Paris.** *Pl.* 21. | 23,467 | 546 | 88½ | 29 | 28,000 N. tur. | La Seyne | 1912 | 1914 | 2,603,920 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 12 *12-in.*, 22 *5·5-in.*, 4 *3-pr.*, Q. F. & M. | 4 (sub.) | 20·0 | 900 / 2700 | 998 |
| ,, | **Provence** *Pl.* 20. | 23,177 | 546 | 88½ | 29 | 29,000 tur. | Lorient | 1913 | 1915 | 2,589,000 | 11–7 K.S. | 2¾–1¾ | 7 K.S. | 7 K.S. | 10½ K.S. | 7 K.S. | 10 *13·4-in.*, 18 *5·5-in.*, 8 l. and M. | 4 (sub.) | 20·0 | 900 / 2700 | 1167 |
| *a.c.* | **Victor Hugo** *Pl.* 22. | 13,108 | 480½ | 70¼ | 27 | 28,486 *t.* B. | Lorient | 1904 | 1907 | 1,229,932 | 6¾–4 H.S. | 2 | 5–3 H.S. | 6 | 8 H.S. | 5 H.S. | 4 *7·6-in.*, 16 *6·4-in.*, 16 *9-pr.*, 8 *3-pr.* | 2 (sub.) | 22·5 *t* | 1320 / 2100 | 728 |
| *b.* | **Voltaire** | 18,754 | 481 | 84 | 27 | 22,500 B. tur. | La Seyne | 1909 | 1911 | 2,169,200 | 10–8 K.S. | 2¾ | 8¾ | .. | 12 K.S. | 8¾ K.S. | 4 *12-in.*, 12 *9·4-in.*, 16 *12-pr.*, 8 *3-pr.*, 2 *1-pr.* | 2 (sub.) | 20·66 *t* | 960 / 2010 | 690 |
| *a.c.* | **Waldeck-Rousseau** | 14,220 | 515 | 70¼ | 27½ | 35,286 Nic. *t.* | Lorient | 1908 | 1911 | 1,301,380 | 6½–3½ | 2½ | 5 | 4¾ | 6 | 5½ | 14 *7·6-in.*, 20 *2·4-in.*, 3 *3-pr.*, 2 *1-pr.* | 2 (sub.) | 23·10 *t* | 1242 / 2300 | 738 |

* The armoured cruisers Condé, Marseillaise, and Montcalm are retained temporarily in this list. They are now employed in training and auxiliary duties.

The battleships Justice, Patrie, République, Démocratie, Vérité, and Vergniaud, and the armoured cruisers Desaix, Gueydon, Aube, Gloire, and Jeanne d'Arc recently removed from the effective list.

Requin, 7214 tons, 2 10·8-in. and smaller guns, gunnery school ship; Latouche-Tréville, 4681 tons, tender to gunnery ship; Pothuau, 5374 tons, training ship.

# FRANCE.—Cruising Ships, &c.

| Class. | NAME. | Displacement. | Length | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| *l. cr.* | **Colmar** (*ex*-Kolberg). | 4280 | 402 | 46 | 16½ | 30,000 *t* (tur.) | Danzig (Schichau) | 1908 | 1910 | 380,870 | .. | 2 | 6 5·9-*in.*, 4 3·4-*in.* (Rearmed 1916). | 2 (sub.) | 26·3 *t* | 890 | 379 |
| ” | **Metz** (*ex*-Königsberg) | 4200 | 450† | 45 | 16 | 45,000 | Bremen(Weser) | 1915 | 1916 | — | 4–2½ | 1 | 7 5·9-*in.*, 3 3·4-*in.* A.A., 2 M. | 4 (sub.) | 28·5 | 1400 | 500 |
| ” | **Mulhouse** (*ex*-Stralsund) | 4480 | 446¼† | 43½ | 15¾ | 35,515 *t* (tur.) | Bremen(Weser) | 1912 | 1913 | 416,340 | 4–2½ | 2 | 7 5·9-*in.*, 2 3·4-*in.* A.A., 2 M. (Rearmed) | 2 (sub.) | 28·27 *t* | 1200 | 373 |
| ” | **Strasbourg** *Pl. 27.* (*ex*-Regensburg) | 4842 | 456† | 45 | 17 | 26,000 (P. tur.) | Bremen(Weser) | 1914 | 1915 | 417,810 | 4–2½ | 2 | 7 5·9-*in.*, 2 3·4-*in.* A.A., 2 M. (Rearmed) | 2 (sub.) | 27·5 | 1279 | 373 |
| ” | **Thionville** (*ex*-Novara) | 3500 | 416¾ | 42 | 15½ | 25,000 (tur.) | Fiume | 1913 | 1914 | .. | 1 | .. | 9 3·9-*in.*, 4 smaller | 1 | 27·0 | 450 850 | 320 |

† Water-line.

In addition is the *ex*-German flotilla leader S 113, now named the Admiral Sénès, in honour of the officer who went down with his flag flying in the Léon Gambetta, when she was torpedoed in 1915. The surrendered German airship L72 received the name of Dixmude.

During the war and subsequently—a few are not yet completed—the following despatch and gun vessels (350-700 tons, 17-22 knots) have been built: Algol, Altaïr, Aldebaran, Antarès, Bellatrix, Cassiopée, Régulus, Quentin-Roosevelt, Dubordieu, Dumont d'Urville, Du Couedic, Du Chaffault, Duperré, Ancre, Ailette, Arras, Bapaume, Escaut, Marne, Oise, Somme, Coucy, Nancy, Amiens, Aisne, Epernay, Lunéville, Péronne, Mondement, Montmirail, Reims, Verdun, Belfort, Epinal, Vauquois, Vimy, Vitry-le-François, Les Eparges, Lassigny, Remiremont, Revigny, Calais, Craonne, Liévin, Baccarat, Béthune, Scarpe, Suippe, Yser, Tahure, Dunkerque, Toul, Ville d'Ys, and Meuse. In this series the vessels bearing the names of stars carry two 5·5-in. and two 6-prs.: those named after old seamen one 5·5-in. and one 3·9-in.; those named in honour of towns famed in the war two 5·5-in. one 12-pr. and 4 M.; and those bearing the names of rivers known in the war four 3·9-in. and five smaller. In the list are 26 other gun-vessels. In addition are the older cruisers D'Entrecasteaux, 8123 tons; D'Estrées, 2460 tons; Du Chayla, 3957 tons; Cassard, 3890 tons; and Jurien de la Gravière, 5690 tons, all over 20 years of age, and several gun-vessels and river gunboats.

Mine-layers Pluton and Cerbère, 560 tons, 6000 I.H.P., 20 knots; twenty-four of the Belliqueuse type, and a large flotilla of mine-trawlers. Submarine chasers fifty-four (internal combustion engines), fifteen (coal). Foudre, 5984 tons, repair ship.

Merchant Auxiliary Cruisers.—La France, 22,500 register tons, 235 knots, Touraine, 8429 register tons, 19·5 knots, Lorraine, 11,869 register tons, 21 knots, Savoie, 11,200 register tons, 22½ knots, of the Compagnie Générale Transatlantique, and some other vessels; also the Amazone, Magellan, Tonkin, and other 17 and 17½ knot boats of the Messageries Maritimes, and the Burdigala, 18 knots, and Lutetia, 20·5 knots, of the Sud Atlantique line.

# GERMANY.

In the following list the letter **A** implies that the ships so marked are to be retained in reserve with their armament, but to have no ammunition on board. They are being used mainly for barrack purposes.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. The 12-prs. are field guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b. | **Braunschweig** | 12,997 | 398½ | 73½ | 24½ | 16,000 T.S. & C. | Germania | 1902 | 1904 | 1,157,500 | 9–4 K.S. | 3 | 6 K.S. | 6 K.S. | 10–6 K.S. | 6 K.S. | 4 *11-in.*, 14 *6·7-in.*, 18 *3·4-in.*, 4 M., 2 *12-pr.* | 5 (sub.) | 18·0 | 700 / 1600 | 743 |
| b. | **Elsass** | 12,997 | 398½ | 72¾ | 24½ | 16,812 W.T.& C. | Danzig (Schichau) | 1903 | 1905 | 1,157,500 | 9–4 K.S. | 3 | 6 K.S. | 6 K.S. | 10–6 K.S. | 6 K.S. | 4 *11-in.*, 14 *6·7-in.*, 18 *3·4-in.*, 4 M., 2 *12-pr.* | 5 (sub.) | 18·7 | 800 / 1600 | 743 |
| b. | **Hannover** | 13,040 | 398½ | 73¾ | 25¼ | 22,492 T.S. *t.* | Wilhelmshaven | 1905 | 1907 | 1,157,500 | 9½–4 K.S. | 3 | 8 K.S. | 6 K.S. | 10–6 K.S. | 6¾ K.S. | 4 *11-in.*, 14 *5·9-in.*, 20 *3·4-in.*, 2 *12-pr.*, 4 M. | 5 (sub.) | 19·16 *t* | 700 / 1800 | 743 |
| b. | **Hessen** | 12,997 | 398½ | 73¾ | 24½ | 16,000 T.S. & C. | Kiel (Germania) | 1903 | 1905 | 1,157,500 | 9–4 K.S. | 3 | 6 K.S. | 6 K.S. | 10–6 K.S. | 6 K.S. | 4 *11-in.*, 14 *6·7-in.*, 18 *3·4-in.*, 4 M., 2 *12-pr.* | 5 (sub.) | 18·0 | 800 / 1600 | 743 |
| b. A | **Lothringen** | 12,997 | 398½ | 73¾ | 24½ | 16,950 W.T.&C. | Schichau (Danzig) | 1904 | 1906 | 1,157,500 | 9–4 K.S. | 3 | 6 K.S. | 6 K.S. | 10–6 K.S. | 6 K.S. | 4 *11-in.*, 14 *6·7-in.*, 20 *3·4-in.*, 4 M., 2 *12-pr.* | 5 (sub.) | 18·54 *t* | 800 / 1600 | 743 |
| b. A | **Preussen** | 12,997 | 398½ | 73¾ | 24½ | 18,374 W.T.& C. | Stettin | 1903 | 1905 | 1,157,500 | 9–4 K.S. | 3 | 6 K.S. | 6 K.S. | 10–6 K.S. | 6 K.S. | 4 *11-in.*, 14 *6·7-in.*, 20 *3·4-in.*, 12 *1 4-in.* & 8 M., 2 *12 pr.* | 5 (sub.) | 18·6 *t* | 1574 / 1600 | 743 |
| b. | **Schlesien** | 13,040 | 398½ | 72¾ | 25¼ | 16,939 T.S. & C. | Schichau | 1906 | 1908 | 1,214,000 | 9½–4 K.S. | 3 | 8 K.S. | 6 K.S. | 11–6 K.S. | 6¾ K.S. | 4 *11-in.*, 14 *5·9-in.*, 20 *3·4-in.*, 2 *12-pr.*, 4 M. | 5 (sub.) | 19·2 | 700 / 1800 | 743 |
| b. | **Schleswig-Holstein** | | | | | | Germania | | | | | | | | | | | | 19·5 *t* | | |

Light cruisers Medusa, Thetis, and Amazone (2630 tons), completed 1901; Arkona, 1903; Hamburg, 1904; Berlin, 1905, all mounting ten *4·1-in.* guns. Also the Nymphe and Niobe (1899, 1901), these two to retain armament, but to have no ammunition on board. The light cruiser to be built at Wilhelmshaven. to replace an older vessel, will be of the Dresden class, 5600 tons, length 508 ft. 6 ins., beam 46 ft. 9 ins., draught 16 ft. 4 ins., 29,000 h.-p., 8 *6-in.*, 3 *22-pr.*, 4 T.T.

Destroyers: S., 23; S., 18; G., 11, 10, 8, 7; V. 6, 5, 3, 2, 1; T. 196. In reserve (to retain armament), S. 19; T. 190, 185, 175.

Torpedo-boats: T. 168, 158, 157, 156, 154, 153, 151, 149, 146, 143, 141, 139. In reserve (to retain armament) T. 152, 148, 144, 135.

## GREECE.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| a.c. | **Giorgios Averoff** *Pl.* 23. | 9956 | 429¾ | 68¾ | 24¾ | 20,000 B | Leghorn (Orlando) | 1910 | 1911 | 1,100,000 | 8–3½ K.S. | 1¾ | 7 | 7 | 8–6½ | 7 | 4 9·2-*in*., 8 7·5-*in*., 16 3-*in*., 8 1·8-*in*. | 3 (sub.) | 24·0 | 700 / 1600 | .. |
| b. | **Hydra** . . . | 4808 | 334½ | 51¾ | 23¼ | 7000 | St. Nazaire La Seyne . | 1889 | 1891 / 1900 | .. | 11¾–4 | 2½ | 3 | .. | 13½ | 13½ | 3 10·6-*in*. Canet, 5 5·9-*in*., 1 3·9-*in*., 8 2·5-*in*., 4 1·8-*in*., 12 1·4-*in*. | 3 | 17·0 | 600 | 400 |
| b. | **Kilkis** (*ex* Mississippi) } **Lemnos** (*ex* Idaho) } *Pl.* 23. | 13,000 | 375 | 77 | 24¾ | 13,607 B.&W. | Phila-delphia | 1905 | 1908 | 616,360 | 9–4 K.S. | 3½–1 K.S. | 7 K.S. | 7 K.S. | 10–7½ K.S. | 6 K.S. | 4 12-*in*., 8 8-*in*., 8 7-*in*., 12 3-*in*., 6 3-*pr*., 14 smaller | 2 (sub.) | 17·1 *t*. | 600 / 1750 | 725 |
| b. | **Psara** . . . | 4808 | 334½ | 51¾ | 23¼ | 7000 | Havre . . La Seyne . | 1890 | 1892 / 1897 | .. | 11¾–4 | 2½ | 3 | .. | 13½ | 13½ | 3 10·6-*in*. Canet, 5 5·9-*in*., 1 3·9-*in*., 8 2·5-*in*., 4 1·8-*in*., 12 1·4-*in*. | 3 | 17·0 | 600 | 400 |
| b. | **Spetsai** . . . | 4808 | 334½ | 51¾ | 23¼ | 7000 | Havre . . La Seyne . | 1889 | 1891 / 1900 | .. | 11¾–4 | 2½ | 3 | .. | 13½ | 13½ | 3 10·6-*in*. Canet, 5 5·9-*in*., 1 3·9-*in*., 8 2·5-*in*., 4 1·8-*in*., 12 1·4-*in*. | 3 | 17·0 | 600 | 400 |

## GREECE.—Cruising Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| cr. | **Helli** (*ex* Fei-Hung) | 2600 | 330 | 42 | 13 | 6500 tur. | Camden, N.J. . | 1912 | 1914 | 240,000 | ¾ | .. | 2 6-*in*., 4 4-*in*., 2 12-*pr*., 6 3-*pr*. | 2 | 22·5 | .. | .. |

***Torpedo depôt-ship.***—Kanaris, 1100 tons, 500 I.H.P., 2 3·9-in. (Krupp) guns, 14 knots speed. Mine-layers Aigialla, Monemvassia, Nauplia. Five old gunboats and four corvettes.

# ITALY.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Deck. | Side above Belt. | Bulkhead. | Gun Position. Heavy Guns. | Second-ary. | Armament. Guns. | Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b. | Andrea Doria | 22,562 (both) | 575¾ | 92 | 29 | 32,000 P. tur. Y. | Spezia | 1913 | 1915 | .. | 10½–6 K.S. | 1¾ | 6 K.S. | .. | 9½ K.S. | 5 K.S. | 13 *12-in.*, 16 *6-in.*, 14 *14-pr.*, 6 *14-pr.* A.A., 4 l. & M. | 3 (sub.) | 23 | 1000<br>2500 | 1074 |
| b. | Caio Duilio *Pl.* 24. | | | | | | Castellammare | 1913 | 1915 | | | | | | | | | | | | |
| b. | Conte di Cavour *Pl.* 25. | 22,023 | 557 | 92 | 29 | 24,000 Parsons B. & W. | Spezia | 1911 | 1915 | .. | 9½–4½ K.S. | 1¾ | 6 K.S. | .. | 9½ K.S. | 5 K.S. | 13 *12-in.*, 18 *4·7-in.*, 14 *12-pr.*, 6 l. & M. | 3 (sub.) | 22·0 | 1000 | 999 |
| b. | Dante Alighieri *Pl.* 25. | 19,400 | 505 | 85 | 27¼ | 35,000*t* Parsons Bl. | Castellammare | 1910 | 1912 | .. | 9½–4½ K.S. | 1½ | 6 K.S. | .. | 10 K.S. | .. | 12 *12-in.*, 20 *4·7-in.*, 14 *12-pr.*, 6 l. | 3 (2 sub.) | 23·8 *t* | 1000<br>2500 | 900 |
| a.c. | Francesco Ferruccio | 7294 | 344 | 59¾ | 23¼ | 13,500 Nic. | Venice | 1902 | 1904 | .. | 6–3 H.S. | 1½ | 6 H.S. | 5 H.S. | 6 H.S. | 6 H.S. | 1 *10-in.*, 2 *8-in.*, 14 *6-in.*, 10 *2·9-in.*, 6 *1·8-in.*, 2 M. | 4 | 20·0 | 655<br>1200 | 540 |
| b. | Giulio Cesare *Pl.* 25. | 22,023 | 557 | 92 | 28 | 34,000 P. B.&W.<br>P. Bl. | Genoa (Ansaldo)<br>Genoa (Odero) | 1911<br>1911 | 1914<br>1914 | .. | 9½–4½ K.S. | 1¾ | 6 K.S. | .. | 9½ K.S. | 5 K.S. | 13 *12-in.*, 18 *4·7-in.*, 14 *12-pr.*, 6 l. & M. | 3 (sub.) | 23·0 *t* | 1000 | 999 |
| b. | Napoli | 12,425 (both) | 435½ | 73½ | 27¼ | 20,000 B.&W. | Castellammare | 1905 | 1909 | 1,120,000 | 9¾–4 H.S. | 2 | 8 H.S. | 8 H.S. | 8 H.S. | 6 H.S. | 2 *12-in.*, 12 *8-in.*, 12 *3-in.*, 12 *1·8-in.* | 2 (sub.) | 22·0 | 1000<br>2000 | 711 |
| b. | Regina Elena | | | | | 20,000 B. | Spezia | 1904 | 1907 | | | | | | | | | | | | |
| a.c. | Pisa *Pl.* 26. | 9956 | 429¾ | 68¾ | 24¾ | 18,000 B. | Leghorn (Orlando) | 1907 | 1908 | .. | 8–3½ K.S. | 1¾ | 7 K.S. | 7 K.S. | 7–6 K.S. | .. | 4 *10-in.*, 8 *7·5-in.*, 16 *3-in.*, 8 l. & M. | 3 (sub.) | 23·0 | 700<br>1600 | 687 |
| b. | Roma | 12,425 | 435½ | 73½ | 27¼ | 20,000 B. & W. | Spezia | 1907 | 1909 | 1,120,000 | 9¾–4 H.S. | 2 | 8 H.S. | 8 H.S. | 8 H.S. | 6 H.S. | 2 *12-in.*, 12 *8-in.*, 12 *3-in.*, 12 *1·8-in.* | 2 (sub.) | 22·0 | 1000<br>2000 | 711 |
| a.c. | San Giorgio | 9832 (both) | 429¾ | 68¾ | 24¾ | 18000 Bl. | Castellammare (both) | 1908 | 1910 | .. | 8–3½ K.S. | 1¾ | 7 K.S. | 7 K.S. | 7–6 K.S. | 7 K.S. | 4 *10-in.*, 8 *7·5-in.*, 16 *3-in.*, 4 l. & M. | 3 (sub.) | 22·5 | 700<br>1600 | 643 |
| a.c. | San Marco *Pl.* 26. | | | | | 18000 tur. | | | | | | | | | | | | | | | |
| a.c. | Varese | 7294 | 344 | 59¾ | 23⅓ | 13,500 B. | Leghorn (Orlando) | 1899 | 1901 | .. | 6–4½ H.S. | 1½ | 6 H.S. | 5 H.S. | 6 H.S. | 6 H.S. | 1 *10-in.*, 2 *8-in.*, 14 *6-in.*, 10 *2·9-in.*, 6 *1·8-in.*, 2 M. | 4 | 20·0 | 650<br>1200 | 500 |
| b. | Vittorio Emanuele III | 12,425 | 435½ | 73½ | 27¼ | 20,000 B. | Castellammare | 1904 | 1907 | 1,120,000 | 9¾–4 H.S. | 2 | 8 H.S. | 8 H.S. | 8 H.S. | 6 H.S. | 2 *12-in.*, 12 *8-in.*, 12 *3-in.*, 12 *1·8-in.* | 2 (sub.) | 22·0 | 1000<br>2000 | 711 |

For the ships removed from the list, see Ch. II. The four ships of the Regina Elena class are condemned. The armoured cruiser Marco Polo, 4511 tons, completed in 1894, has been converted into a troopship and renamed Cortellazzo. Monitor Faa di Bruno and armed pontoons Carso, Cucco, and Vodice, 1,650 tons, 2 *15-in.*, 4 *14-pr.*, and 6 light guns.

# ITALY.—Cruising Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armaments. Guns. | Armaments. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| *Scout* | **Alessandro Poerio** | 1012 | 279 | 26¼ | 9¼ | 20,000 turb. | Genoa (Ansaldo) | 1914 | 1915 | .. | .. | .. | 6 *4-in.*, 4 *2-pr.* A.A. | 2 dbl. | 32·0 | 400 | 100 |
| *l. cr.* | **Ancona** (*ex* German Graudenz) *Pl. 27.* | 4842 | 456 | 45 | 17 | 27,400 | Kiel | 1913 | 1914 | .. | .. | .. | 7 *5·9-in.*, 2 *22-pr.* 2 M. | 2 *19·7 in.* | 27·5 | 1279 | .. |
| *Scout* | **Aquila** | 1500 | 310 | 31 | 10½ | 39,800 | Genoa (Ansaldo) | 1915 | 1916 | .. | .. | .. | 3 *6-in.*, 4 *12-pr.* A.A.; carry 100 mines | 4 | 35·0 | 350 Oil | 160 |
| " | **Augusto Riboty** | | | | | 43,190 | | | | | | | | | | | |
| *l.c.* | **Bari** (*ex*-German Pillau) | 4320 | 441† | 46 | 19¼ | 27,400 turb. | Danzig (Schichau) | 1914 | 1914 | .. | .. | 1 | 8 *5·9-in.*, 2 *3·4-in.* A.A. (Rearmed) | 5 | 27·5 | 1000 | .. |
| " | **Brindisi** (*ex*-Austrian Helgoland) | 3500 | 416¾ | 42 | 15½ | 25,000 Tur. | Fiume | 1912 | 1914 | .. | 1 | .. | 9 *3·9-in.*, 4 smaller | 2 | 27·0 | 450 850 | 320 |
| *Scout* | **Carlo Mirabello** | 1476 | 331 | 31·3 | 10½ | 48,100 | Genoa (Ansaldo) | 1914 | 1916 | .. | .. | .. | 8 *4-in.*, 2 *12-pr.* A.A.; carries 100 mines | 4 | 35·0 | 350 Oil | 140 |
| *Flot. ldr.* | **Cesare Rossarol** (*ex*-German B. 97) | 1354 | 321 | 30¾ | 9¾ | 40,200 | Hamburg | 1916 | 1917 | .. | .. | .. | 4 *4-in.*; carries 24 mines | 6 | 37·5 | 150 526 | .. |
| *Scout* | **Falco** | 1460 | 310 | 31 | 10½ | 38,100 | Naples (Pattison) | .. | 1918 | .. | .. | .. | 3 *6-in.*, 4 *12-pr.* A.A.; carries 120 mines | 2 dbl. | 35·0 | 200 | 160 |
| " | **Guglielmo Pepe** | 1012 | 279 | 26¼ | 9¼ | 22,730 turb. | Genoa (Ansaldo) | 1914 | 1915 | .. | .. | .. | 6 *4-in.*, 4 *2-pr.* A.A.; mining equipment | 2 dbl. | 32·0 | 400 | 100 |
| " | **Leone** | 2158 | 359 | 33½ | 11¼ | 42,000 turb. | Genoa (Ansaldo) | Bldg. | .. | .. | .. | .. | 8 *4·7-in.*, 2 *14-pr.* A.A., 2 M.; mining equipment | 6 | 34·0 | 200 400 | .. |
| *l. cr.* | **Libia** | 3690 | 341½ | 47 | 16 | 12,500 | Genoa (Ansaldo) | 1912 | 1913 | .. | 1½ | .. | 2 *6 in.*, 8 *4·7-in.*, 14 smaller | 2 | 22·0 | 630 | 300 |
| *Scout* | **Marsala** | 3400 | 460½ | 42¾ | 13¼ | 22,500 P.tur,Bl. | Castellammare | 1912 | 1914 | .. | 1¾ | .. | 6 *4·7-in.* and 6 *12-pr.*; mining equipment | 2 | 28·0 | 800 | 240 |

† Water line.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scout* | **Nino Bixio** | 3400 | 460½ | 42¾ | 13¼ | 22,500 Bl.Cur.t. | Castellammare | 1911 | 1914 | .. | 1¾ |
| " | **Pantera** | 2158 | 359½ | 33½ | 11¼ | 42,000 | Gen[illegible] | | | | |
| " | **Premuda** | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Scout* . | **Nino Bixio** . . | 3400 | 460¼ | 42⅜ | 13¼ | 22,500 Bl.Cur.t. | **Castellammare** . | 1911 | 1914 | .. | 1½ | .. | 6 *4·7-in.* and 6 *12-pr.*, mining equipment | 2 | 27·7 | 800 | 300 |
| „ | **Pantera** . . . | 2158 | 359½ | 33½ | 11¼ | 42,000 turb. | Genoa (Ansaldo) . | Bldg. | .. | .. | .. | .. | 8 *4·7-in.*, 2 *14-pr.* A.A., 2 M., mining equipment | 6 | 32·0 | 400 / 200 | 100 |
| „ . | **Premuda** . . (*ex* German V. 116) | 2500 | 360 | 36 | 14 | 4500 approx. | Hamburg . . | 1918 | 1919 | .. | .. | .. | 4 *5·9-in.* . . . . | 4 *23·6 in.* | 35 | 600 Oil | .. |
| „ . | **Quarto** . . . | 3220 | 432 | 43⅜ | 13¼ | 29,000 P.tur.Bl. | Venice . . . | 1911 | 1912 | .. | 1½ | .. | 6 *4·7-in.* and 6 *12-pr.*, mining equipment | 2 | 28·6 | 450 | 240 |
| *l.c.* . | **Taranto** (*ex*-German Strassburg) | 4480 | 446¼† | 43½ | 15⅜ | 33,742 *t* P. tur. | Wilhelmshaven . | 1912 | 1912 | 416,340 | 4-2½ | 2 | 7 *5·9-in.*, 2 *3·4-in.* A.A., 2 M. (Rearmed) | 2 (sub.) | 28·28 *t* | 1200 | 373 |
| *Scout* . | **Tigre** . . . | 2158 | 359½ | 33½ | 11¼ | 42,000 turb. | Genoa (Ansaldo) . | Bldg. | .. | .. | .. | 8 | 3 *4·7-in.*, 2 *14-pr.* A.A., 2 M., mining equipment | 6 | 34·0 | 200 / 400 | .. |
| *l.c.* . | **Venezia** (*ex*-Austrian Saida) | 3500 | 416⅜ | 42 | 15½ | 25,000 Tur. | Monfalcone . . | 1912 | 1914 | .. | 1 | .. | 9 *3·9-in.*, 4 smaller . . | 2 | 27·0 | 450 / 850 | 320 |

The scouts have been built to act also as flotilla leaders.

**Etna** (3474 tons), converted into a training ship. Agordat, mining vessel. Coal and liquid fuel transport Bronte (9490 tons). An oil transport with under-water protection, the Brennero, is under construction at Riva Trigoso. Anteo, submarine salvage vessel. Lagoon and river gunboats and mine-layers Sebastiano Cabot, Brondolo, and Marghera, 1900 tons, 17 knots. E. Carlotto building. Surveying vessel, Ammiraglio Magnaghi, 1800 tons, 14 knots. Small vessels, Capitano Verri (*ex*-Thetis) and Bengazi (*ex*-Derna) captured from the Turks. About 50 various patrolling vessels, 10 gunboats, and some mine layers. During the war a great number of motor chasers (M.A.S.) were bought and built, and at the beginning of 1921 about 350 of these were still on the list.

† Water line.

# JAPAN.—Armoured Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement.† |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b.c. | Akagi . . | 40,000 | 850 | 100 | .. | .. | Kure | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 8 *16-in.*, 20 5 *5-in.* .. | 8 | 33 | .. | .. |
| " | Amagi* . | | | | | | Yokosuka | | | | | | | | | | | | | | |
| b. | Aki . . . *Pl. 30.* | 19,800 | 460 | 83½ | 27½ | 24,000 My. tur. | Kure . . | 1907 | 1910 | .. | 9–5 K. S. | 2–3 | 8 | .. | 9 | 6 | 4 *12-in.*, 12 *10-in.*, 8 *6-in.*, 8 *12-pr.*, 8 l. and M. | 5 (sub.) | 20·5 | .. | 937 |
| b. | Fuso . . . *Pl. 29.* | 30,600 | 630 | 94 | 28½ | 40,000 tur. | Kure . | 1914 | 1915 | .. | 12 K.S. | 3 | 6 K.S. | .. | 12 K.S. | 6 K.S. | 12 *14-in.*, 16 *6-in.*, 4 *12-pr.* A.A. | 6 (sub.) | 23 | 1500 / 4000 | 1193 |
| b. | Hyuga . . | 31,260 | 640 | 94 | 28½ | 45,000 tur. | Nagasaki (Mitsubishi) | 1917 | 1918 | | | | | | | | 12 *14-in.*, 20 *5·5-in.*, 4 *12-pr.* A.A. | 6 (sub.) | 23 | 1500 / 4000 | 1360 |
| b.c. | Haruna . | 27,500 | 653½ | 92 | 27½ | 64,000 My. P. t. My. C. t. | Kobe . (Kawasaki) | 1913 | 1915 | .. | 8–6 K.S. | 2¾ | .. | .. | 10 K.S. | 7 K.S. | 8 *14-in.*, 16 *6-in.*, 4 *12-pr.*, A.A. | 8 (sub.) | 27·5 | 1000 / 4000 | 980 |
| " | Hiyei . . *Pl. 32.* | | | | | | Yokosuka . | 1912 | 1914 | | | | | | | | | | | | |
| b. | Hizen (*ex* Retvizan) | 12,700 | 374 | 72¼ | 25 | 16,000 My. | Philadelphia | 1900 | 1902 | .. | 9–4 K.S. | 4 | 6–2 K.S. | 9 K.S. | 10 K.S. | 5 K.S. | 4 *12-in.*, 12 *6-in.*, 20 smaller. | 2 | 18·0 | 800 / 2000 | 791 |
| a.c. | Ibuki . . . | 14,620 | 450½ | 75½ | 26¼ | 27,000 My. tur. | Kure . . | 1907 | 1910 | .. | 7–4 K.S. | 2 | 5 K.S. | .. | 9 K.S. | 5½ K.S. | 4 *12-in.*, 8 *8-in.*, 14 *4·7-in.*, 3 *1·8-in.*, 8 l. and M. | 3 (sub.) | 22 | 600 / 2000 | 846 |
| " | Idzumo . | 9750 | 400 | 68½ | 24½ | 17,300 B. *t.* | Elswick | 1899 | 1900 | .. | 7–3½ H.N.S. | 2½ | 5 H.N.S. | .. | 6 H. N.S. | 6 H. N.S. | 4 *8-in.*, 14 *6-in.*, 12 *12-pr.*, 8 *2½-pr.* | 4 (sub.) | 22·0 | 600 / 1412 | 688 |
| " | Iwate . . | | | | | | | 1900 | 1901 | | | | | | | | | | 21·7 *t* | | |

* Atago and Takao, battle-cruisers of this class, are expected to be laid down in 1922 at the Kawasaki Company's yard, Kobe, and the Mitsubishi yard, Nagasaki, after the launching of the battleships Kaga and Tosa. Four other battle-cruisers are in the programme.

† The complements of Japanese ships vary considerably from time to time. These given are the latest reports.

| | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a.c. | **Ikoma** | | 13,750 | 440 | 75 | 26 | 22,670 My. | Kure | 1906 | 1908 | .. | 7–5 K.S. | 1½ | .. | .. | 7 K.S. | 5 K.S. | 4 *12-in.*, 10 *6-in.*, 8 *4·7-in.*, 2 *1·8-in.*, 2 l., 4 M. | 3 (sub.) | 21·0 | 600 2000 | 918 |
| b. | **Ise** | | 31,260 | 640 | 94 | 28½ | 45,000 P. tur. | Kobe (Kawasaki) | 1916 | 1917 | .. | 12 K.S. | 3 | 6 K.S. | .. | 12 K.S. | 6 K.S. | 12 *14-in.*, 20 *5·5-in.*, 4 *12-pr.* A.A. | 6 (sub.) | 23·0 | 1000 4000 | 1360 |
| b. | **Kaga** * | | 40,600 | 700 | .. | .. | .. | Kobe (Kawasaki) | Bldg. | .. | .. | 14 K.S. | .. | .. | .. | .. | .. | 8 *16-in*, 20 *5·5-in.*, 4 *12 pr.* A.A. | 8 | 23·5 | .. | .. |
| b. | **Kashima** | *Pl.* 31. | 16,400 | 425 | 78⅛ | 27 | 17,280 Nic. | Elswick | 1905 | 1906 | .. | 9–4 K.S. | 3–2½ | 6 | 6 | 9 K.S. | 6 K.S. | 4 *12-in.*, 4 *10-in.*, 12 *6-in.*, 12 *12-pr.*, 5 M., 2 l. | 5 (sub.) | 19·2 *t* | 750 2150 | 946 |
| a.c. | **Kasuga** | | 7630 | 344 | 62 | 24¼ | 14,900 | Sestri Ponente | 1902 | 1904 | 760,000 | 6 H. N.S. | 1½ | 6 H. N.S. | 6 H. N.S. | 6 H. N.S. | 6 H. N.S. | 1 *10-in.*, 2 *8-in.*, 14 *6-in.*, 10 *3-in.*, 6 *1·8-in.*, 2 M. | 4 | 20·0 | 600 1150 | 595 |
| b. | **Katori** | *Pl.* 31. | 15,975 | 420 | 78 | 27 | 18,500 *t*, Nic. | Barrow | 1905 | 1906 | .. | 9–5 K.S. | 3–2 | 6 | 6 | 10 K.S. | 6 K.S. | 4 *12-in.*, 4 *10-in.*, 12 *6-in.*, 12 *12-pr.*, 5 M., 2 l. | 5 (sub.) | 19·5 *t* | 750 1800 | 946 |
| b.c. | **Kirishima** | *Pl.* 32. | 27,500 | 653½ | 92 | 27½ | 64,000 My P t. | Nagasaki (Mitsubishi) | 1913 | 1915 | .. | 8–6 K.S. | 2¾ | .. | .. | 10 K.S. | 7 K.S. | 8 *14-in.*, 16 *6-in.*, 4 *12-pr.*, A.A. | 8 (sub.) | 27·5 | 1100 4000 | 980 |
| ,, | **Kongo** | *Pl.* 32. | 27,500 | 653½ | 92 | 27½ | 64,000 Y. P. t. | Barrow | 1913 | 1913 | 2,500,000 | 8–6 K.S. | 2¾ | .. | .. | 10 K.S. | 7 K.S. | 8 *14-in.*, 16 *6-in.*, 4 *12-pr.*, A.A. | 8 (sub.) | 27·5 | 1100 4000 | 980 |
| a.c. | **Kurama** | | 14,620 | 450½ | 75½ | 26¼ | 27,000 My. | Yokosuka | 1907 | 1909 | .. | 7–4 K. S. | 2 | 5 K.S. | .. | 9 K. S. | 6 K.S. | 4 *12-in.*, 8 *8-in.*, 14 *4·7-in.*, 3 *1·8-in.*, 2 l., 4 M. | 3 (sub.) | 21·2 | 600 2000 | 846 |
| b. | **Mikasa** | | 15,362 | 400 | 76 | 27¼ | 16,431 B. | Barrow | 1900 | 1901 | .. | 9–4 H.N.S. | 3 | 6 H.N.S. | 12 H.N.S. | 14 H.N.S. | 6 H.N.S. | 4 *12-in.*, 4 *10-in.*, 14 *6-in.*, 26 small | 4 (sub.) | 18·5 *t* | 700 1520 | 820 |
| b. | **Mutsu** * | | } | | | | | Yokosuka | 1920 | .. | } | | | | | | | | | | | |
| b. | **Nagato** | *Pl.* 28. | 33,800 | 700 | .. | .. | 46,000 | Kure | 1919 | 1920 | .. | 12 K.S. | .. | .. | .. | .. | .. | 8 *16-in.*, 20 *5·5-in.*, 4 *12-pr.* A.A. | 8 (4 sub.) | 23·5 | .. | 1336 |
| a.c. | **Nisshin** | | 7630 | 344 | 61⅓ | 24¼ | 13,500 | Sestri Ponente | 1903 | 1904 | 760,000 | 6 H. N.S. | 1½ | 6 H. N.S. | 6 H. N.S. | 6 H. N.S. | 6 H. N.S. | 4 *8-in.*, 14 *6-in.*, 10 *3-in.*, 6 *1·8-in.*, 2 M. | 4 | 20·0 | 600 1150 | 611 |
| b. | **Satsuma** | *Pl.* 31. | 19,350 | 450 | 83½ | 27½ | 19,370 My. | Yokosuka | 1906 | 1910 | .. | 9–5 K. S. | 2–3 | 8 | .. | 9 | 6 | 4 *12-in.*, 12 *10-in.*, 12 *4·7-in.*, 4 *12-pr.*, 8 l. and M. | 5 (sub.) | 18·5 | 750 2860 | 940 |
| b. | **Settsu** | *Pl.* 30. | 20,800 | 500 | 84 | 27 | 26,500 tur. | Kure | 1911 | 1912 | .. | 12–9½ K.S. | 2½ | 9 K.S. | .. | 12 K.S. | 6 K.S. | 12 *12-in.*, 10 *6-in.*, 8 *4·7-in.*, 16 small, l. and M. | 5 (sub.) | 20·5 | 900 2500 | 991 |
| b. | **Tosa** * | | 40,600 | 700 | .. | .. | .. | Nagasaki (Mitsubishi) | Bldg. | .. | .. | 14 K.S. | .. | .. | .. | .. | .. | 8 *16-in.*, 20 *5·5-in.*, 4 *12-pr.* A.A. | 8 | 23·5 | .. | .. |
| a.c. | **Yakumo** | | 9850 | 407¾ | 64¼ | 23¾ | 16,000 B. | Stettin | 1899 | 1901 | .. | 7–3½ H. S. | 2½ | 5 H.S. | .. | 6 H. S. | 6 H.S. | 4 *8-in.* (A.), 12 *6-in.*, 12 *12-pr.* (A.), 8 *2½-pr.* | 5 (4 sub.) | 20·0 | 600 1100 | 698 |
| b. | **Yamashiro** | *Pl.* 29. | 30,600 | 630 | 94 | 28½ | 40,000 tur. | Yokosuka | 1915 | 1917 | .. | 12 K.S. | 3 | 6 K.S. | .. | 12 K.S. | 6 K.S. | 12 *14-in.*, 16 *6-in.*, 4 *12 pr* A.A. | 6 (sub.) | 23·0 | .. | .. |

* Particulars uncertain.

Four additional battleships are in the programme, of which two, the Kii and Owari, have been named; and have been allotted respectively to the Kure and Yokosuka Dockyards, where they will be laid down when the battle-cruisers Amagi and Akagi have been launched in 1921 or 1922. They are to be completed in 1923 or 1924.

The battleship Aso (*ex*-Bayan), 8100 tons, completed at La Seyne in 1903, and having a complement of 791 officers and men, is now classed as a mine-layer.

The old battleships Asahi, Fuji, Shikishima, and Suwo, the armoured cruisers Adzuma, Asama, and Tokiwa, and the coast-defence ships Mishima and Okinoshima have been removed from the list. The Iwami is rated as a coast-defence ship.

# JAPAN.—Cruising Ships, &c.

| ...ss. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| ...r. | Chikuma | 4950 | 440 | 46½ | 16¾ | 22,500 Cur. t. My. | Sasebo | 1911 | 1912 | .. | 2¼ | .. | 8 *6-in.*, 4 *3-in.*, 4 M. | 3 | 26 | 500 1000 | 413 |
| „ | Hirado | 4950 | 440 | 46½ | 16¾ | 22,500 P. tur. My. | Kobe | 1911 | 1912 | .. | 2¼ | .. | 8 *6-in.*, 4 *3-in.*, 4 M. | 3 | 26 | 500 1000 | 390 |
| „ | Isudzu | | | | | | Uraga | Bldg. | .. | | | | | | | | |
| „ | Kiso | 5500 | 500 | 46¾ | 15¾ | .. | Nagasaki (Mitsubishi) | 1920 | .. | .. | 2 | .. | 7 *5·5-in.*, 2 *12-pr.* A.A. | 8 | 36·0 | .. | 439 |
| „ | Kitakami | | | | | | Sasebo | 1920 | 1921 | | | | | | | | |
| „ | Kuma | | | | | | Sasebo | 1919 | 1920 | | | | | | | | |
| Scout | Mogami | 1350 | 300 | 31½ | 9¾ | 8000 turbines | Nagasaki | 1908 | 1909 | .. | .. | .. | 2 *4·7-in.*, 4 *12-pr.* | 2 | 23·0 | 95 350 | 167 |
| l.cr. | Nagara | 5500 | 500 | 46¾ | 15¾ | .. | Sasebo | 1921 | .. | .. | 2 | .. | 7 *5·5-in.*, 2 *12-pr.* A.A. | 8 | 36·0 | .. | 439 |
| „ | Natori | | | | | | Nagasaki (Mitsubishi) | Bldg. | | | | | | | | | |
| „ | Niitaka | 3420 | 235½ | 44 | 16½ | 10,000 Nic. | Yokosuka | 1902 | 1904 | .. | 2½ | .. | 6 *6-in.*, 10 *3-in.*, 1 *12-pr.* A.A. | .. | 20·0 | 280 600 | 387 |
| „ | Oh-i | 5500 | 500 | 46¾ | 15¾ | .. | Kobe | 1920 | .. | .. | 2 | .. | 7 *5·5-in.*, 2 *12-pr.* A.A. | 8 | 36·0 | .. | 439 |
| .b. | Saga | 785 | 210 | 29½ | 7½ | 1600 | Sasebo | 1912 | 1912 | .. | .. | .. | 1 *4·7-in.*, 2 *3-in.*, 3 M. | .. | 15 | 90 190 | 87 |
| ...r. | Tama | 5500 | 500 | 46¾ | 15¾ | .. | Nagasaki (Mitsubishi) | 1920 | 1921 | .. | 2 | .. | 7 *5·5-in.*, 2 *12-pr.* A.A. | 8 | 36 | .. | 439 |
| „ | Tatsuta | 3500 | 440 | 41 | 13 | .. | Sasebo | 1918 | 1919 | .. | .. | .. | 4 *5·5-in.*, 1 *12-pr.* (mining equipment) | 6 | 31 | .. | 322 |
| „ | Tenryu | | | | | | Yokosuka | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| „ | **Tone** . . . . | 4100 | 400 | 47 | 16¾ | 15,000 My. | Sasebo . . | 1907 | 1909 | .. | 2½ | .. | 2 *6-in.*, 10 *4·7-in.*, 2 *12-pr.*, 2 l. | 3 | 23·0 | 300 900 | 401 |
| *l. cr.* | **Tsushima** . . . | 3420 | 235 | 44 | 16½ | 10,000 Nic. | Kure . . | 1902 | 1904 | .. | 2½ | .. | 6 *6-in.*, 10 *3-in.*, 9 l. & M. . | .. | 20·0 | 600 | 307 |
| *g.b.* | **Uji** . . . . | 620 | 180½ | 27½ | 10 | 1000 B. | Kure . . | 1903 | 1903 | .. | .. | .. | 4 *12-pr.*, 3 M. . . . | .. | 13·0 | 100 | 80 |
| *l. cr.* | **Yahagi** . . . | 4950 | 440 | 46½ | 16¾ | 22,500 P. tur. My. | Nagasaki . . | 1911 | 1912 | .. | 2¼ | .. | 8 *6-in.*, 4 *3-in.*, 4 M. . . | 3 | 26 | 500 1000 | 413 |
| „ | **Yodo** . . . . | 1250 | 280 | 32 | 9¾ | 6500 | Kobe . . | 1907 | 1908 | .. | .. | .. | 2 *4·7-in.*, 4 *12-pr.* . . | 2 | 22·0 | 125 340 | 166 |
| „ | **Yura** . . . . | 5500 | 500 | 46¾ | 15¾ | .. | Sasebo . . | Bldg. | .. | .. | 2 | .. | 7 *5·5-in.*, 2 *12-pr.* A.A. . | 8 | 36 | .. | 439 |

A light cruiser of the Kuma class, named Kinu, was laid down at the Kawasaki yard in January, 1921, and four others are to be built as follows: Ayase (Sasebo), Otonase (Nagasaki), Abukama (Uraga) and Minase (Uraga).

The river gunboat Nakoso is in hand at Yokohama, and the Katata, Hodzu, Hira and Seta, of the same class, are to be built.

Submarine depôt ships Karasaki (*ex*-Ekaterinoslav), 6170 tons, 5 light guns; Komahasi and Nagaru Maru. Minelayers: Tsuguro (*ex*-Pallada), 6630 tons; two building or projected; 12 converted merchant vessels. Aircraft depôt ship Wakamiya. Aircraft carrier Hosho building.

Repair ship Kwanto Maru, 6190 tons. Colliers: Noshima, Maroto. Oil ships: Erimo, Notari, Shiretoko, Sunesaki Maru, Tsurugisaki.

Gunboats Toba, 250 tons; Fushimi, 180 tons; and Sumida, 126 tons.

# NETHERLANDS.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. | | | | | | Armament. | | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Belt. | Deck. | Side above Belt. | Bulkhead. | Gun Position. Heavy Guns. | Gun Position. Second-ary. | Guns. | Torpedo Tubes. | | | |
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots | tons. | |
| a.g.b. | Brinio . . . } Friso . . . } Gruno . . . } | 520 | 171 | 28 | 9¼ | 1200 | Amsterdam . | 1912 1913 | 1915 | .. | 2 K.S. | ¾ | .. | .. | .. | .. | 4 *4·1-in.* semi-automatic, 2 M. | .. | 16 | Oil | 49 |
| c.d.s. | De Ruyter . *Pl.* 33. | 5000 | 316¾ | 51½ | 21¾ | 6377 *t.* | Rotterdam . | 1901 | 1904 | 347,500 | 6–4 H.N.S. | 2 | .. | .. | 10 H.N.S. | 3 H.S. | 2 *9·4-in.*, 4 *5·9-in.*, 10 *2·9-in.*, 4 *1·4-in.* | 3 2 sub. | 16·5 *t* | 680 | 347 |
| ” | Hertog Hendrik . *Pl.* 33. | 5000 | 316¾ | 50 | 21¾ | 6000 Y. | Amsterdam . | 1902 | 1903 | 347,500 | 6 H.N.S. | 2 | .. | .. | 10 H.N.S. | 3 H.S. | 2 *9·4-in.*, 4 *5·9-in.*, 10 *2·9-in.*, 4 *1·4-in.*, 2 l. | 3 | 16·5 | 680 | 347 |
| ” | Jacob van Heems-kerck | 4921 | 316¾ | 50 | 21¾ | 6000 Y | Amsterdam . | 1906 | 1908 | 347,500 | 6–4 H.N.S. | 2 | .. | .. | 10 H.N.S. | 6 H.N.S. | 2 *9·4-in.*, 6 *5·9-in.*, 6 *12-pr.*, 4 *1·4-in.*, 2 l. | 3 2 sub. | 16·0 | 680 | 351 |
| ” | Koningin Regentes *Pl.* 33. | 5000 | 316¾ | 50 | 21¾ | 7290 Y. | Amsterdam . | 1900 | 1902 | 347,500 | 6–4 H.N.S. | 2 | .. | .. | 10 H.N.S. | .. | 2 *9·4-in.*, 4 *5·9-in.*, 6 *2·9-in.*, 4 *1·4-in.*, 2 l. | 3 2 sub. | 16·5 | 680 | 347 |
| ” | Marten Tromp . *Pl.* 33. | 5216 | 316¾ | 50 | 21¾ | 6377 *t* | Amsterdam . | 1904 | 1906 | 347,500 | 6–4 H.N.S. | 2 | .. | .. | 10 H.N.S. | 3 H.S. | 2 *9·4-in.*, 4 *5·9-in.*, 10 *2·9-in.*, 4 *1·4-in.* | 3 2 sub. | 16·5 *t* | 680 | 349 |
| ” | De Zeven Provin-cien | 6426 | 339½ | 56 | 20¼ | 7500 Y. | Amsterdam . | 1909 | 1910 | .. | 6–4 K.S | 2 | .. | .. | 10 K.S. | 4 K.S. | 2 *11-in.*, 4 *5·9-in.*, 10 *12-pr.* | .. | 16·0 | 700 | 409 |

The Zeven Provincien, Koningin Regentes, De Ruyter, and Hertog Hendrik are assigned to the Fleet of the Dutch East Indies. The light cruisers Java and Sumatra, intended for service in the East Indies, are building respectively at Flushing and Amsterdam. The Sumatra was launched at Amsterdam on December 30—7050 tons, 65,000 H.P., 30 knots, ten 6-in., four 3-in. guns. Light cruisers: Gelderland (1900), 4030 tons, ten 4·7-in., four 3-in., four 1·4 in., 2 M., one torpedo tube, 20 knots; Zeeland (1897), 3900 tons, two 5·9-in., eight 4·7-in., two 2·9-in., four 1·4-in., 2 M., 19·4 knots. Four gun-vessels of small value are in Home waters. There are two modern mine-layers, Medusa and Hydra, two others, Triton and Vulcanus, and six old vessels converted to the same use. Two additional mine-layers, 750 tons, are in hand at Schiedam. In 1920 two old gunboats were in commission in the East Indies, as well as four mine-layers, Assahan, Sardang, Siboga, and Hercules. Surveying vessels in the East Indies, Van Gogh, Van Doorn, Lombok, Sumbawa, Tydeman. Depôt ship for submarines (Pelikaan) building at Amsterdam for the East Indies.

# NORWAY.—Armoured Ships.

| Class. | NAME | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour: Belt. | Armour: Deck. | Armour: Side above Belt. | Armour: Bulkhead. | Armour: Gun Position: Heavy Guns. | Armour: Gun Position: Second-ary. | Armament: Guns. | Armament: Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | in. | in. | | | knots. | tons. | |
| c.d.s. | Eidsvold . / Norge . *Pl.* 33. | 4233 | 290 | 50½ | 16½ | 4500 Y. | Elswick | 1900 | 1901 | 350,000 | 6 H.N.S. | 2 | .. | .. | 6 H.N.S. | 6 H.N.S. | 2 *8·2-in.* 6 *6-in.*, 8 *12-pr.*, 6 *3-pr.* | 2 sub. | 16·9 *t* | 400 / 600 | 270 |
| „ / „ | Harald Haarfagre . / Tordenskjold | 3920 | 280 | 48½ | 16½ | 3700 | Elswick | 1896 / 1897 | 1898 / 1899 | 300,000 | 7 H.S. | 2 | .. | .. | 8 H.S. | .. | 2 *8-in.*, 6 *4·7-in.*, 6 *12-pr.*, 6 *1½-pr.* | 2 sub. | 17·2 *t* | 200 / 500 | 249 |

# Cruising Ships.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour: Deck. | Armour: Gun Position. | Armament: Guns. | Armament: Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| g.b. | Æger . . . | 387 | 108½ | 29½ | 8 | 450 | Horten . | 1892 | 1893 | .. | 1½ | .. | 1 *8·2-in.*, 1 *2·7-in.*, 2 *1·9-in.* . . | .. | 9·0 | .. | 43 |
| g.b. | Frithjof . . | 1349 | 216½ | 32¾ | 13¼ | 2800 | Horten . | 1896 | 1898 | .. | .. | .. | 2 *4·7-in.*, 6 *12-pr.*, 4 *1·4-in.*, 2 l. . | 3 sub. | 15·0 | 120 | 166 |
| g.v. | Heimdal . . | 620 | 167¼ | 26¾ | 11¾ | 700 | Christiania . | 1892 | 1893 | .. | .. | .. | 4 *12-pr.* . . . . . . . | .. | 12·0 | 62 | 62 |

*Seven Gunboats*, of 189 to 280 tons, and of 180 to 450 I.H.P., armed with one large gun and machine guns.

# SPAIN.—Armoured Ships.

| ss | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| | Alfonso XIII. *Pl.* 34. | 15,460 | 435 | 78¾ | 25½ | 15,300Y. P. tur. | Ferrol | 1913 | 1916 | .. | 9–4 K.S. | 2–1 | 6–5 K.S. | 6–3 K.S. | 10 K.S. | 6 K. | 8 *12-in.*, 20 *4-in.*, 2 *3-pr.*, 2 l., 2 M. | 3 | 19·5 | 800 1805 | 735 |
| *a.c.* | Cataluña | 7405 | 347¾ | 61 | 23¼ | 10,580 | Cartagena | 1900 | 1908 | 600,000 | 12–10 | 2 | .. | 12 | 10½ | .. | 2 *9·4-in.*, 8 *5·5-in.*, 8 *6-pr.*, 2 l., 10 *1-pr.* | 5 sub. | 19·5 *t* | 1200 | 546 |
| " | Emperador Carlos V. *Pl.* 34. | 9089 | 380 | 67 | 27½ | 15,000 | Cadiz (Vea Murguia) | 1895 | 1898 | 734,000 | 2 | 6½–2 | 2 | .. | 10 | 2 | 2 *11-in.* (Hontoria), 8 *5·5-in.*, 4 *3·9-in.*, 7 l. & M. | 2 | 19·0 | 2508 | 583 |
| *b.* | España | 15,460 | 435 | 78¾ | 25½ | 15,300Y. P. tur. | Ferrol | 1912 | 1913 | .. | 9–4 K.S. | 2–1 | 6–5 K.S. | 6–3 K.S. | 10 K.S. | 6 K. | 8 *12-in.*, 20 *4-in.*, 2 *3-pr.*, 2 l., 2 M. | 3 | 20·0 *t* | 1305 | 700 |
| *b.* | Jaime I. *Pl.* 34. | | | | | | | 1914 | 1915 | | | | | | | | | | 20·5 | 1850 | |
| *b.* | Pelayo | 9744 | 330 | 66 | 25 | 8000 Nic. | La Seyne | 1887 | 1888 1897 | .. | 17¾ | 4 | .. | .. | 19¼ | 4 H.S. | 2 *12·6-in.*, 2 *11-in.*, 9 *5·5-in.*, 2 l., 12 *6-pr.*, 9 *1-pr.* | 3 | 16·0 | 676 | 620 |
| *a.c.* | Princesa de Asturias | 7427 | 347¾ | 61 | 23¾ | 11,791 | Cadiz | 1896 | 1902 | 600,000 | 12–10 | 2 | .. | 12 | 10½ | .. | 2 *9·4-in.*, 10 *5·5-in.*, 8 *6-pr.*, 2 l., 10 *1-pr.* | 5 | 18·0 | 1007 | 546 |

# SPAIN.—Cruising Ships.

| Class | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | ins. | | | | knots. | tons. | |
| g.b. | Bonifaz | 800 | 200 | 30 | 9½ | 1100 Y | Cartagena | 1911 | 1912 | .. | .. | .. | 4 3-in., 2 M. | .. | 14·0 | .. | 121 |
| to.g.b. | Don Alvaro de Bazán | 810 | 233 | 26¾ | 11¼ | 3577 | Ferrol | 1897 | 1899 | .. | .. | .. | 6 6-pr., 2 2½-pr., 8 6-pr., 2 M. | 4 | 19·0 | .. | 121 |
| „ | Doña María de Molina | 810 | 233 | 26¾ | 11¼ | 2500 | Ferrol | 1896 | 1898 | | | | | | | | |
| cr. | Extremadura | 2100 | 288 | 36 | 16¼ | 7000 T | Cadiz | 1900 | 1902 | .. | 2 | .. | 8 4-in. (Vickers), 4 2·2-in., 4 1-pr. | .. | 20·0 | 430 | 266 |
| g.b. | Lauria | 800 | 200 | 30 | 9½ | 1100 Y | Cartagena | 1911 | 1912 | .. | .. | .. | 4 3-in., 2 M. | .. | 14·0 | .. | 121 |
| „ | Laya | | | | | | | | 1911 | | | | | | | | |
| to.g.b. | Marqués de la Victoria | 810 | 233 | 26¾ | 11 | 2711 | Ferrol | 1897 | 1900 | .. | .. | .. | 8 6-pr., 2 M. | 4 | 19·0 | .. | 121 |
| g.b. | Recalde | 800 | 200 | 30 | 9½ | 1100 Y | Cartagena | 1911 | 1911 | .. | .. | .. | 4 3-in., 2 M. | .. | 13·8 | .. | .. |
| l. cr. | Reina Regente | 5778 | 337 | 52½ | 16¼ | 11,000 W.T. | Ferrol | 1906 | 1910 | .. | .. | 3 | 10 5·9-in., 12 2·2-in., 2 l., 8 1-pr. | 3 | 20·0 | 1200 | 452 |
| „ | Reina Victoria Eugenia | 5590 | 364 | 50 | 16½ | 22,500 T. | Ferrol | 1920 | .. | .. | 2 (1½ side) | .. | 9 6-in., 1 12-pr., 4 3-pr. | 4 (sub.) | 25·0 | .. | .. |
| „ | B. & C. | 4820 | 339½ | 46 | 15 | .. | Ferrol | Bldg. | .. | .. | .. | .. | 6 6-in., 4 12-pr., 4 M. | 4 | 29 | .. | .. |

Three coastal gunboats of 1500 tons and 18 knots are in hand at Ferrol.

Hernán Cortés, Vasco Nuñez de Balboa, Marqués de Molins, MacMahon, Perla, gun-vessels.

ght cruiser Rio de la Plata, 1773 tons, converted to a mine-layer. Esmeralda and twelve other mine-trawlers and auxiliaries. Submarine salvage vessel Canguru, 2100 tons (1916).

# SWEDEN.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| d.s., t. | **Aeran** | 3650 | 287 | 49¼ | 16½ | 6500 Y. | Gothenburg | 1901 | 1902 | .. | 7 K.S. | 1⅞ | .. | .. | 7½ K.S. | 5 K.S. | 2 *8·2-in.*, 6 *5·9-in.*, 10 *2·2-in.*, 1 *1·4-in.*, 2 M. | 2 sub. | 17·2 *t* | 370 | 250 |
| „ | **Dristigheten** | 3620 | 285 | 48½ | 16 | 5400 Y. | Gothenburg | 1900 | 1901 | .. | 8 K.S. | 1⅞ | .. | .. | 8 N.S. | 3¾ K.S. | 2 *8·2-in.*, 6 *5·9-in.*, 10 *2·2-in.*, 1 *1·4-in.*, 2 M. | 2 sub. | 16·5 | 300 | 250 |
| a.c. | **Drottning-Victoria** *Pl. 35.* | 7605 | 390½ | 61 | 21½ | 22,000 tur. Y. | Gothenburg | 1917 | 1921 | 666,000 | 8–6 K.S. | 12 | 4 H.S. | .. | 8 K.S. | 5 K.S. | 4 *11-in.*, 8 *6-in.*, 6 *12-pr.*, 2 *2·2-in.*, 2 M. | 2 sub. | 24·0 *t* | 350 / 800 | 450 |
| „ | **Fylgia** | 4980 | 377¼ | 48¾ | 16 | 12,440 Y. *t* | Stockholm | 1905 | 1907 | 385,700 | 4 K.S. | 2 | .. | .. | 5 K.S. | 5 K.S. | 8 *5·9-in.*, 14 *2·2-in.*, 2 *1·4-in.* | 2 | 22·5 *t* | 350 / 900 | 321 |
| „ | **Gustav V.** *Pl. 35.* | 7605 | 390½ | 61 | 21½ | 22,000 tur. Y. | Malmö | 1917 | 1920 | 666,000 | 8–6 K.S. | 12 | 4 H.S. | .. | 8 K.S. | 5 K.S. | 4 *11-in.*, 8 *6-in.*, 6 *12-pr.*, 2 *2·2-in.*, 2 M. | 2 sub. | 22·0 | 350 / 800 | 450 |
| d.s., t. | **Manligheten** | 3870 | 287 | 49¼ | 16½ | 7400 Y. | Malmö | 1904 | 1906 | .. | 7 K.S. | 1⅞ | .. | .. | 7½ K.S. | 5 K.S. | 2 *8·2-in.*, 6 *5·9-in.*, 8 *2·2-in.*, 1 *1·4-in.* | 2 sub. | 17·0 | 370 | 250 |
| „ | **Oscar II** *Pl. 35.* | 4658 | 313¾ | 49½ | 16¾ | 8500 Y. | Gothenburg | 1905 | 1907 | .. | 6 K.S. | 2 | 6 K.S. | 6 K.S. | 7½ K.S. | 5 K.S. | 2 *8·2-in.*, 8 *6-in.*, 10 *2·2-in.*, 4 *1·4-in.* | 2 sub. | 18·0 | 350 / 500 | 326 |
| a.c. | **Sverige** *Pl. 35.* | 7605 | 390½ | 61 | 21½ | 20,000 tur. Y. | Stockholm | 1914 | 1918 | 666,000 | 8–6 K.S. | 1½ | 4 K.S. | .. | 8 K.S. | 5 K.S. | 4 *11-in.*, 8 *6-in.*, 6 *12-pr.*, 2 *2·2-in.*, 2 M. | 2 sub. | 22·0 | 350 / 800 | 450 |
| d.s., t. | **Tapperheten** | 3990 | 287¼ | 49¼ | 16½ | 6000 Y. | Malmö | 1901 | 1904 | .. | 7 K.S. | 1⅞ | .. | .. | 7½ K.S. | 5 K.S. | 2 *8·2-in.*, 6 *5·9-in.*, 8 *2·2-in.*, 1 *1·4-in.*, 2 M. | 2 sub. | 16·5 | 370 | 250 |
| „ | **Wasa** | 3745 | 287 | 49¼ | 16½ | 6000 Y. | Stockholm | 1901 | 1893 | .. | 7 K.S. | 1⅞ | .. | .. | 7½ K.S. | 5 K.S. | 2 *8·2-in.*, 6 *5·9-in.*, 10 *2·2-in.*, 1 *1·4-in.* | 2 sub. | 16·5 | 370 | 250 |

Older coast-defence ships Göta and Thule (1891–1894), 3393 tons, 1 8·2-in., 7 5·9-in. guns; Oden, Thor, Njord (1890, 1898, 1899), 3715 tons, 2 9·8-in., 6 4·7-in. guns. Torpedo gunboats Claes Horn, Jacob Bagge, Oernen, Psilander, 830 tons, 2 4·7-in., 4 2·2-in., 20 knots. Four gunboats, 200 tons, each 1·5-in. guns.

# UNITED STATES.—Armoured Ships.

N.B.—All the ships and vessels of the United States Navy, of every class, are now differentiated as belonging to the First Line or Second Line. In the following lists the First Line ships are marked with an asterisk.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. § | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| b. | Alabama . | 11,552 | 368 | 72¼ | 24¾ | 11,207 t | Philadelphia | 1898 | 1900 | 544,539 | 16½–4 H.S. | 2¾–4 | 5¼ H.S. | 12 H.S. | 15 H.S. | 6 H.S. | 4 13-in., 8 6-in., 2 3-in. A.A., 16 6-pr., 10 1-pr., 4 M., 2 l. | .. | 21·9 t | 800 / 1275 | 592 |
| b. | *Arizona . | 31,400 | 600 | 97 | 28¾ † | 34,000 Y. | New York . (Navy Yard) | 1915 | 1916 | 1,485,000 | 14 K.S. | 3 | .. | .. | 18 K.S. | .. | 12 14-in. (45 cal.), 14 5-in., 4 3-in. A.A., 4 6-pr. | 4 (sub.) | 21·0 | 2914 Oil | 1002 |
| b. | *Arkansas . *Pl. 41.* | 26,000 | 554 | 93¼ | 28½ † | 28,533 P. tur. | Camden, N.J. (N.Y.S.B.Co.) | 1911 | 1912 | 964,000 | 11–5 K.S. | 3 | .. | 8–6 K.S. | 11 K.S | 6½ | 12 12-in., 16 5-in., 2 3-in. A.A., 4 3-pr., 4 M., 1 l. | 2 (sub.) | 21·0 t | 1650 / 2500 | 1115 |
| a. c. | Brooklyn . | 9215 | 400½ | 62 | 26½ | 18,425 t | Philadelphia | 1895 | 1896 | 613,583 | 3 H.S. | 6–3 | 4 H.S. | .. | 8 H.S. | 5½ H.S. | 8 8-in., 8 5-in., 2 3-in. A.A., 14 6-pr., 10 1-pr., 2 M., 1 l. | .. | 22·2 t | 900 / 1622 | 718 |
| b. | *California . *Pl. 38.* | 32,400 | 624 | 97½ | 30¼ | 28,500 | Mare Island (Navy Yard) | 1919 | 1921 | .. | 14 K.S. | .. | .. | .. | 18 K.S. | 9 K.S. | 12 14-in. (50 cal.), 14 5-in., 4 3-in. A.A., 9 M. & l. | 2 (sub.) | 21·0 | 2914 Oil | 1067 |
| a. c. | Charleston . | 9700 | 424 | 66 | 35 † | 27,500 B.&W. | Newport News | 1904 | 1906 | 563,030 | 4 H.S | 3 | 4 H.S. | .. | 4 H.S. | .. | 12 6-in., 4 3-in., 2 3-in. A.A., 10 M., 2 l. | .. | 22·0 | 650 / 1500 | 664 |
| a.c. | Charlotte (*ex* North Carolina) | 14,500 | 502 | 72¾ | 25 ‡ | 29,785 B. & W. | Newport News | 1906 | 1908 | 970,630‡ | 5–3 K.S. | 3 | 5 K.S. | 6 K.S. | 9 K.S. | 5 K.S. | 4 10-in., 4 6-in., 12 3-in., 2 3-in. A.A., 4 6-pr., 15 M. & l. | 4 sub. | 21·9 t | 900 / 2000 | 845 |
| b. | *Colorado . Pl. 37. | 32,600 | 600 | 97½ | 30½ † | 28,900 T. | N.Y.S.B. Co. | 1921 | .. | 1,383,000 | 16–14 K.S. | .. | .. | .. | 18 K.S. | 9 K.S. | 8 16-in. (45 cal.), 14 5-in., 4 3-in. A.A., 4 6-pr. | 2 (sub.) | 21·0 | .. | .. |
| b. | Connecticut . | 16,000 | 450 | 76¾ | 26¾ | 20,525 B. & W. | Camden, N.J. | 1904 | 1906 | 819,300 | 11½ K.S. | 3 | 8 K.S. | 7 K.S. | 10 K.S. | 7 K.S. | 4 12-in., 8 8-in., 12 3-in., 2 3-in. A.A., l., M., and A.A. | 4 (sub.) | 18·8 t | 900 / 2200 | 803 |
| b.c. | *Constellation | 43,500 | 850 | 105½ | 31 † | 180,000 tur. electric | Newport News | Bldg. | .. | Actual cost and supple-ment. | .. | .. | .. | .. | .. | .. | 8 16-in. (50 cal.), 16 6-in., 4 3-in. A.A., 4 6-pr. | 8 (4 sub.) | 33·3 | Oil | 1315 |
| ,, | *Constitution *Pl. 43.* | | | | | | Philadelphia | | | | | | | | | | | | | | |
| b. | *Delaware . *Pl. 42.* | 20,000 | 510 | 85¼ | 27 † | 28,578 | Newport News | 1909 | 1910 | 817,300 | 11 K.S. | .. | 10–8 K.S. | .. | 11 K.S. | 5 K.S. | 10 12-in., 14 5-in., 2 3-in. A.A., 16 M. & l. | 2 (sub.) | 21·5 t | 1000 / 2500 | 927 |
| b. | *Florida . *Pl. 42.* | 21,825 | 510 | 88¼ | 28½ † | 27,036 tur. | New York . (Navy Yard) | 1910 | 1911 | 1,280,000 | 11 | .. | 10 | .. | 11 | 5 | 10 12-in., 16 5-in., 4 3-in. A.A., 6 l. and M. | 2 (sub.) | 22·1 t | 1000 / 2300 | 1014 |
| a.c. | Frederick . (*ex* Maryland) | 13,680 | 502 | 69½ | 24½ | 28,059 B. & W. | Newport News. | 1903 | 1905 | 756,400 | 6–3½ K.S. | 4 | 5 K.S. | 4 K.S. | 6 K.S. | 5 K.S. | 4 8-in., 4 6-in., 10 3-in., 2 3-in. A.A., 14 l. | 2 (sub.) | 22·4 t | 900 / 1850 | 829 |

§ The sums given in this column are exclusive of the cost of armour and armament according to the system of making appropriations in the estimates. Congress fixed the limit of cost of the six battleships of the North Carolina class at 21,000,000 dollars each, but the Iowa and Massachusetts are being built on the basis of actual cost plus a fixed profit of 1,650,000 dollars. The six battle cruisers are being built on a cost plus 10 per cent. basis, with limit of cost of 23,000,000 dollars.

† Mean draught.

‡ Including armour, but not armament.

# UNITED STATES.—Armoured Ships—*continued.*

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. $ | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bul head. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Coal. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | | in. | in. | in. | in. | in. | in. | | | knots | tons | |
| *Super-posed turrets.* | **Georgia** . | 14,948 | 435 | 76¼ | 23¾ † | 25,088 *t* Nic. | Bath, Me. | 1904 | 1906 | 737,700 | 11–4 K.S. | 3 | 6 K.S. | 6 K.S. | 11 K.S. | 6 K.S. | 4 *12-in.*, 8 *8-in.*, 8 *3-in.*, 2 *3-in* A.A., 4 *3-pr.*, 17 l. | 4 (sub.) | 19·2 *t* | 900 / 1704 | 812 |
| *a c.* | **Huntington** (*ex* West Virginia) | 13,680 | 502 | 69½ | 24½ | 31,437 B. & W. | Newport News | 1903 | 1905 | 798,310 | 6–3½ K.S. | 4 | 5 K.S. | 12 H.S. | 6 K.S. | 5 K.S. | 4 *8-in.*, 4 *6-in.*, 10 *3-in.*, 2 *3-in.* A.A., 8 *1-pr.*, 4 M., 1 l. | 2 (sub.) | 22·1 *t* | 900 / 2000 | 829 |
| *a.c.* | **Huron** (*ex* South Dakota) | 13,680 | 502 | 69½ | 26 | 28,598 B. & W. | S. Francisco. | 1904 | 1907 | 770,570 | 6–3½ K.S. | 4 | 5 K.S. | 4 K.S. | 6 F S. | 5 K.S. | 4 *8-in.*, 4 *6-in.*, 10 *3-in.*, 2 *3-in.* A.A., 7 *1-pr.*, 1 l. | 2 sub. | 22·0 *t* | 900 / 2000 | 829 |
| *b.* | ***Idaho** . | 32,000 | 624 | 97¼ | 30 † | 32,000 Y. | Camden, N.J. (N Y.S.B. Co.) | 1917 | 1919 | 1,485,000 | 14 K.S. | 3 | .. | .. | 18 K.S. | .. | 12 *14-in.* (50 cal.), 14 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.*, 4 M. | 2 (sub.) | 21·0 | 2914 Oil | 1007 |
| *b.* | ***Indiana** . *Pl.* 36. | 43,200 | 660 | 106 | 33 † | 60,000 T. electric | New York Navy Yard | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. | 2 (sub.) | 23 0 | Oil | 1470 |
| *b.* | **Illinois** . | 11,552 | 368 | 72¼ | 24¾ | 12,757 | Newport News | 1898 | 1901 | 533,237 | 16½–4 H.S. | 2¾–4 | 5½ H.S. | 12 H.S. | 15 H.S. | 6 H.S. | 4 *13-in.*, 8 *6-in.*, 2 *3-in.* A.A., 4 *6-pr.*, 6 *1-pr.*, 17 M., 2 l. | .. | 17·45 *t* | 800 / 1275 | 686 |
| *b.* | ***Iowa** . *Pl.* 36. | 43,200 | 660 | 106 | 33 † | 60,000 tur.electric | Newport News | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. | 2 (sub.) | 23·0 | Oil | 1470 |
| *b.* | **Kansas** . | 16,000 | 450 | 77 | 26¾ | 19,545 B. & W. | Camden, N.J. | 1905 | 1907 | 855,850 | 8–11 K.S. | 3–4½ | 8 K.S. | 7 K.S. | 10 K.S. | 7 K.S. | 4 *12-in.*, 8 *8-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 14 M. and l. | 4 (sub.) | 18·1 *t* | 900 / 2200 | 854 |
| *Super-posed turrets.* | **Kentucky** | 11,520 | 368 | 72¼ | 25 | 12,179 | Newport News | 1898 | 1899 | 462,345 each | 16½–4 H.S. | 2¾–5 | 5½ H.S. | .. | 15 H.S. | 9 H.S. | 4 *13-in.*, 4 *8-in.*, 8 *5-in.*, 2 *3-in.* A.A., 8 M. and l. | .. | 16·9 *t* | 410 / 1591 | {690 / 686 |
| *b.c.* | ***Lexington** . *Pl.* 43. | 43,500 | 850 | 105½ | 31 † | 180,000 tur.electric | Quincy, Mass. | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 8 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. M. and l. | 8 (4 sub.) | 33·3 | Oil | 1315 |
| *b* | **Louisiana** . | 16,000 | 450 | 76¾ | 26¾ | 20,748 B. & W. | Newport News | 1904 | 1906 | 819,300 | 11–8 K.S. | 3 | 8 K.S. | 7 K.S. | 10 K.S. | 7 K.S. | 4 *12-in.*, 8 *8-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 24 M. and l. | 4 (sub.) | 18·8 *t* | 900 / 2200 | 803 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| b. | *Maryland Pl. 37. | 32,600 | 600 | 97¼ | 30½ † | 28,900 T. | Newport News | 1920 | 1922 | 1,383,000 | 16–14 K.S. | .. | .. | .. | 18 K.S. | 9 K.S. | 8 *16-in.* (45 cal.), 14 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.* | 2 (sub.) | 21·0 | .. | .. |
| b. | *Massachusetts Pl. 36. | 43,200 | 660 | 106 | 33 † | 60,000 tur.electric | Quincy, Mass. Bethlehem | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. | 2 (sub.) | 23·0 | Oil | 1470 |
| b. | Michigan | 16,000 | 450 | 80¼ | 24½ † | 16,310 B. & W. | Camden, N.J. | 1908 | 1909 | 700,000 | 11–9 | 3 | 8 | 10 | 10–8 | 8 | 8 *12-in.*, 12 *3-in.*, 2 *3-in.* A.A., 2 *3-pr.*, 2 M., 1 l. | 2 (sub.) | 18·8 *t* | 900 2200 | 669 |
| b. | Minnesota | 16,000 | 450 | 77 | 26¾ | 20,235 B. & W. | Newport News | 1905 | 1907 | 844,500 | 8–11 K.S. | 3–4½ | 8 K.S. | 7 K.S. | 10 K.S. | 7 K.S. | 4 *12-in.*, 8 *8-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 14 *1-pr.*, 4 M. | 4 (sub.) | 18·8 *t* | 900 2200 | 881 |
| b. | *Mississippi | 32,000 | 624 | 97¾ | 30 † | 32,000 Y. | Newport News | 1917 | 1917 | 1,485,000 | 14 K.S. | 3 | .. | .. | 18 K.S. | .. | 12 *14-in.* (50 cal.), 14 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.* 14 l. | 2 sub. | 21·0 | 2914 Oil | .. |
| a.c. | Missoula (*ex* Montana) | 14,500 | 502 | 72¾ | 27 † | 27,938 B. & W. | Newport News | 1906 | 1908 | 970,630‡ | 5–3 K.S. | 3 | 5 K.S. | 6 K.S. | 9 K.S. | 5 K.S. | 4 *10-in.*, 4 *6-in.*, 2 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 10 *1-pr.*, 4 M., 1 l. | 4 sub. | 22·2 *t* | 900 2000 | 845 |
| b. | *Montana Pl. 36. | 43,200 | 660 | 106 | 33 † | 60,000 tur.electric | Mare Island Cal. Navy Yard | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A A. | 2 (sub.) | 23·0 | Oil | 1470 |
| Super-posed turrets. | Nebraska | 14,948 | 435 | 76¼ | 23¾ † | 21,283 B. & W. | Seattle. | 1904 | 1907 | 767,210 | 11–4 K.S. | 3 | 6 K.S. | 6 K.S. | 11 K.S. | 6 K.S. | 4 *12-in.*, 8 *8-in.*, 8 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 20 *1-pr.*, 4 M., 1 l. | 4 sub. | 19·1 *t* | 900 1900 | 812 |
| b. | *Nevada Pl. 39. | 27,500 | 575 | 95 | 28½ † | 23,312 Cur. tur. | Quincy, Mass. (Fore River) | 1914 | 1915 | 1,211,342 | 13½–8 K.S | 1½–3 | 13½–8 K.S. | 13½ K.S. | 18–16 K.S. | 5 K.S. | 10 *14-in.* (45 cal.), 12 *5-in.*, 2 *3-in.* A.A., 4 *6-pr.*, 18 l. & M. | 2 sub. | 20·5 | 1300 2000 | .. |
| b. | NewHampshire | 16,000 | 450 | 77 | 26¾ | 19,100 B. & W. | Camden, N.J. | 1906 | 1908 | 1,600,000 (Total) | 9–4 K.S. | 3 | 7 K.S. | 7 K.S. | 12 K.S. | 7 K.S. | 4 *12-in.*, 8 *8-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *6-pr.*, 14 *1-pr.*, 4 M. | 4 sub. | 18·2 *t* | 900 2350 | 916 |
| Super-posed turrets. | New Jersey | 14,948 | 435 | 76¼ | 23¾ † | 23,089 B. & W. | Quincy, Mass. | 1904 | 1906 | 699,680 | 11–4 K.S. | 3 | 6 K.S. | 6 K.S. | 11 K.S. | 6 K.S. | 4 *12-in.*, 8 *8-in.*, 8 *3-in.*, 2 *3-in.* A A., 4 *3-pr.*, 8 *1-pr.*, 4 M., 1 l. | 4 sub. | 19·4 *t* | 900 1900 | 812 |
| b. | *New Mexico | 32,000 | 624 | 97¾ | 30 † | 27,500 Y. Electric drive | New York (Navy Yard) | 1917 | 1918 | 1,485,000 | 14 K.S. | 3 | .. | .. | 18 K.S. | .. | 12 *14-in.* (50 cal.), 14 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.* 6 l. & M. | 2 (sub.) | 21·4 | 2914 Oil | .. |
| ,, | *New York Pl. 40. | 27,000 | 565 | 95¼ | 28½ † | 29,687 | New York (Navy Yard) | 1912 | 1914 | 1,315,114 | 12–4 K.S | 3 | 9 K.S. | 10 K.S. | 14–8 K.S. | 6 K.S. | 10 *14-in.* (45 cal.), 16 *5-in.*, 2 *3-in.* A.A., 4 *3-pr.* 13 l. & M. | 4 sub. | 21·5 | 2200 2850 | 1074 |

◊ See note on page 367. † Mean draught. ‡ Including armour, but not armament.

# UNITED STATES.—Armoured Ships—*continued.*

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. § | Armour. Belt. | Armour. Deck. | Armour. Side above Belt. | Armour. Bulkhead. | Armour. Gun Position. Heavy Guns. | Armour. Gun Position. Second-ary. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Normal Coal Supply. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | in. | in. | in. | in. | | | knots. | tons. | |
| *b.* | ***North Carolina**<br>*Pl.* 36. | 43,200 | 660 | 106 | 33<br>† | 60,000<br>tur.electric | Norfolk, Va.<br>(Navy Yard) | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. | 2<br>(sub.) | 23·0 | Oil | 1470 |
| *b.* | ***North Dakota**<br>*Pl.* 42. | 20,000 | 510 | 85¼ | 28¾<br>† | 31,000<br>Cur. tur. | Quincy,Mass.<br>(Fore River) | 1908 | 1910 | 899,500 | 11<br>K.S. | .. | 10–8<br>K.S. | .. | 11<br>K.S. | 5<br>K.S. | 10 *12-in.*, 14 *5-in.*, 2 *3-in.* A.A., 2 *3-pr.*, 14 l., 4 M. | 2<br>sub. | 21·0<br>*t* | 1000<br>2500 | 960 |
| *b.* | **Ohio** | 12,500 | 388 | 72¼ | 25½ | 16,220<br>T. | S. Francisco. | 1901 | 1904 | 595,705 | 11·4<br>K.S. | 3–4 | 6<br>K.S. | 10<br>K.S. | 12<br>K.S. | 6<br>K.S. | 4 *12-in.*, 8 *6-in.*, 2 *3-in.* A.A., 4 *6-pr.*, 16 *1-pr.*, 2 M., 1 l. | 2<br>sub. | 17·8<br>*t* | 1000<br>2144 | 521 |
| *b.* | ***Oklahoma**<br>*Pl.* 39. | 27,500 | 575 | 95 | 29¾<br>† | 21,703 | New York | 1914 | 1915 | 2,200,000 | 13½–8<br>K.S. | 1½–3 | 13½–8<br>K.S. | 13½<br>K.S. | 18–16<br>K.S. | 5<br>K.S. | 10 *14-in.* (45 cal.), 12 *5-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 19 l. & M. | 2<br>sub. | 20·5 | 1300<br>2000 | .. |
| *b.* | ***Pennsylvania** | 31,400 | 600 | 97 | 29¾<br>† | 31,500<br>*t* Y. | Newport News | 1915 | 1916 | 1,485,000 | 14<br>K.S. | 3 | .. | .. | 18<br>K.S. | .. | 12 *14-in.* (45 cal.), 12 *5-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 14 l., 4 M. | 2<br>sub | 21·0 | 2914<br>Oil | 1002 |
| *a.c.* | **Pittsburg** | 13,680 | 502 | 69½ | 26 | 28,600<br>Nic. | Philadelphia<br>(Cramp) | 1903 | 1905 | 799,340 | 6–3½<br>K.S. | 4 | 5<br>K.S. | 4<br>K.S. | 6<br>K.S. | 5<br>K.S. | 4 *8-in.*, 4 *6-in.*, 10 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 18 *1-pr.*, 8 M., 1 l. | 2<br>sub. | 22·4<br>*t* | 900<br>2000 | 829 |
| *a. c.* | **Pueblo**<br>(*ex* Colorado) | 13,680 | 502 | 69½ | 24½ | 26,837<br>Nic. | Philadelphia | 1903 | 1905 | 756,000 | 6–3½<br>K.S. | 4 | 5<br>K.S. | 4<br>K.S. | 6<br>K.S. | 5<br>K.S. | 4 *8-in.*, 4 *6-in.*, 10 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 12 *1-pr.*, 4 M., 1 l. | 2<br>(sub.) | 22·2<br>*t* | 900<br>2000 | 829 |
| *b.c.* | ***Ranger**<br>*Pl.* 43. | 43,500 | 850 | 105½ | 31<br>† | 180,000<br>tur.electric | Newport News | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 8 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A., M. & l. | 8 (4<br>sub.) | 33·3 | Oil | 1315 |
| *Super-posed* | **Rhode Island** | 14,948 | 435 | 76¼ | 26<br>† | 20,310<br>B. & W. | Quincy,Mass. | 1904 | 1906 | 699,680 | 11–4<br>K.S. | 3 | 6<br>K.S. | 6<br>K.S. | 11<br>K.S. | 6<br>K.S. | 4 *12-in.*, 8 *8-in.*, 8 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 8 *1-pr.* | 4<br>sub. | 19·0<br>*t* | 900<br>1900 | 812 |
| *a.c.* | **Rochester**<br>(*ex* Saratoga) | 8200 | 380½ | 64¾ | 26¼<br>† | 17,075 | Philadelphia<br>(Cramp) | 1891 | 1893<br>1909 | 613,377 | 4<br>H.S. | 2½ | ..<br>K.S. | .. | 6½<br>H.S. | 5–4<br>H.S. | 4 *8-in.*, 8 *5-in.*, 2 *3-in.* A.A., 19 l. & M. | .. | 21·0<br>*t* | 750<br>1334 | 498 |

| | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a.c. | **St. Louis** | 9700 | 424 | 66 | 22½ † | 27,264 B. & W. | Philadelphia (Cramp) | 1905 | 1906 | 563,030 | 4 K.S. | 3 | 4–3 | .. | 4 K.S. | .. | 12 *6-in.*, 4 *3-in.*, 2 *3-in.* A.A., 2 *3-pr.*, 12 l. & M. | .. | 22·1 *t* | 650 / 1500 | 664 |
| b.c. | ***Saratoga** *Pl.* 43. | 43,500 | 850 | 105½ | 31 † | 180,000 | N.Y. Ship-building Co. | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 8 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A., M. & l. | 8 (4 sub.) | 33·3 | Oil | 1315 |
| a.c. | **Seattle** (*ex* Washington) | 14,500 | 502 | 72¾ | 27 | 27,152 B. & W. | Camden, N.J. | 1905 | 1906 | 970,630‡ | 5–3 K.S. | 3 | 5 K.S. | 6 K.S. | 9 K.S. | 5 K.S. | 4 *10-in.*, 4 *6-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *6-pr.*, 4 M., 11 l. | 4 sub. | 22·3 *t* | 900 / 2000 | 858 |
| b. | **South Carolina** | 16,000 | 450 | 80¼ | 27 † | 18,357 B. & W. | Philadelphia (Cramp) | 1908 | 1909 | 730,000 | 11–9 | 3 | 8 | 10 | 10–8 | 8 | 8 *12-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 M., 11 l. | 2 sub. | 18·9 *t* | 900 / 2200 | 669 |
| b. | ***South Dakota** *Pl.* 36. | 43,200 | 660 | 106 | 33 † | 60,000 tur. electric | New York Navy Yard | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 12 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A. | 2 (sub.) | 23·0 | Oil | 1470 |
| b. | ***Tennessee** Pl. 38. | 32,300 | 600 | 97¼ | 30¼ † | 28,500 T. | New York Navy yard | 1919 | 1920 | .. | 14 K.S. | .. | .. | .. | 18 K.S. | 9 K.S. | 12 *14-in.* (50 cal.), 14 *5-in.*, 4 *3-in.* A.A., 9 M. & l. | 2 sub. | 21·0 | 2941 Oil | 1007 |
| b. | ***Texas** *Pl.* 40. | 27,000 | 565 | 95¼ | 28½ † | 28,100 *t* | Newport News | 1912 | 1914 | 1,166,000 | 12–4 K.S. | 3 | 9 K.S. | 10 K.S. | 14–8 K.S. | 6 K.S. | 10 *14-in.* (45 cal.), 16 *5-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 13 l. | 4 sub. | 21·1 *t* | 2200 / 2850 | 1074 |
| b. c. | ***United States** *Pl.* 43. | 43,500 | 850 | 105½ | 31 † | 180,000 tur. elec. | Philadelphia Navy yard | Bldg. | .. | .. | .. | .. | .. | .. | .. | .. | 8 *16-in.* (50 cal.), 16 *6-in.*, 4 *3-in.* A.A., M. & l. | 8 (4 sub.) | 33·3 | Oil | 1315 |
| b. | ***Utah** *Pl.* 42. | 21,825 | 510 | 88¼ | 28½ | 28,477 *t.*, P. tur. | Camden, N.J. | 1909 | 1911 | 813,500 | 11 | .. | 10 | .. | 11 | 5 | 10 *12-in.*, 16 *5-in.*, 4 *3-in.* A.A., 4 *3-pr.*, 2 M. & l. | 2 sub. | 21·6 *t* | 1000 / 2300 | 1014 |
| b. | **Vermont** | 16,000 | 450 | 77 | 26¾ | 17,982 B. & W. | Quincy, Mass. | 1905 | 1907 | 858,730 | 8–11 K.S. | 3–4½ | 8 K.S. | 7 K.S. | 10 K.S. | 7 K.S. | 4 *12-in.*, 8 *8-in.*, 12 *3-in.*, 2 *3-in.* A.A., 4 *3-pr.*, 8 *1-pr.*, 2 M., 1 l. | 4 sub. | 18·33 *t* | 900 / 2200 | 854 |
| Super-posed | **Virginia** | 14,948 | 435 | 76¼ | 23¾ † | 22,841 Nic. | Newport News | 1904 | 1906 | 737,700 | 11–8 K.S. | 3 | 6 K.S. | 6 K.S. | 11 K.S. | 6 K.S. | 4 *12-in.*, 8 *8-in.*, 8 *3-in.*, 2 *3-in.* A.A., 8 *1-pr.*, 2 M., 1 l. | 4 sub. | 19·0 *t* | 900 / 1900 | 812 |
| b. / b. | ***Washington** / ***West Virginia** Pl. 37. | 32,600 | 600 | 97¼ | 30½ † | 28,900 T. | N.Y.S.B. Co. / Newport News | 1920 / Bldg. | .. | 1,383,000 | 16–14 K.S. | .. | .. | .. | 18 K.S. | 9 K.S. | 8 *16-in.* (45 cal.), 14 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.* | 2 sub. | 21·0 | .. | .. |
| b. | ***Wyoming** *Pl.* 41. | 26,000 | 554 | 93¼ | 29¾ † | 31,437 P. tur. | Philadelphia | 1911 | 1912 | 963,800 | 11–9 K.S. | .. | .. | 8–6 K.S. | 11 K.S. | 8 | 12 *12-in.*, 6 *5-in.*, 4 *3-in.* A.A., 4 *6-pr.*, 4 M., 13 l. | 2 sub. | 21·2 *t* | 1650 / 2500 | 1115 |

§ See note on p. 367. † Mean Draught. ‡ Including armour, but not armament.

Coast battleships No. 1 (*ex* Indiana); Oregon, 10,288 tons; No. 4 (*ex* Iowa), 11,346 tons: four 13-in., eight 8-in., four 3-in. guns; completed 1895–97. Monitors Monadnock, 3990 tons, Tonopah (*ex* Nevada), 3714 tons, Tallahassee (*ex* Florida) and Ozark (*ex* Arkansas), 3235 tons, Cheyenne (*ex* Wyoming) 3218 tons, Monterey, 4084 tons. The coast battleship No. 2 (*ex* Massachusetts) was handed over to the War Department to be used as a target. The Maine, Missouri, and Wisconsin have recently been disposed of.

# UNITED STATES.—Cruising Ships, &c.

| Class. | NAME. | Displacement. | Length. | Beam. | Draught. | Indicated Horse-Power. | Where Built. | Date of Launch. | Date of Completion. | Cost. § | Armour. Deck. | Armour. Gun Position. | Armament. Guns. | Armament. Torpedo Tubes. | Speed. | Normal Coal Supply. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | tons. | ft. | ft. | ft. | | | | | £ | in. | in. | | | knots. | tons. | |
| p.v. | Albany | 3487 | 346 | $43\frac{3}{4}$ | 29 | 7500 | Elswick | 1899 | 1900 | 247,611 | 3 | $3-1\frac{1}{4}$ shields | 8 *5-in.*, 1 *3-in.* A.A., 2 *3-pr.*, 2 *1-pr.*, 4 M., 1 l. | .. | 20·5 *t* | 512 / 747 | 356 |
| g.v. | Asheville | 1575 | 225 | $41\frac{1}{4}$ | $11\frac{1}{4}$† | 800 P. tur. | Charleston | 1918 | 1919 | 176,718 | .. | .. | 3 *4-in.*, 2 *3-pr* | .. | 12 | .. | 157 |
| scout cr. | Birmingham | 3750 | 420 | 47 | $18\frac{3}{4}$† | 15,670 Express | Quincy, Mass. | 1907 | 1908 | 301,000 | $2-1\frac{1}{2}$ | .. | 4 *5-in.*, 2 *3-in.*, 1 *3-in.* A.A., 4 M. | 2 sub. | 24·3 *t* | 1250 / 1433 | 356 |
| p.v. | Chattanooga | 3200 | 292 | 44 | 17 | 5303 B.& W. | Elizabeth Port | 1903 | 1904 | 212,325 | 2 | .. | 6 *5-in.*, 1 *3-in.* A.A., 4 *6-pr.*, 2 *1-pr.*, 2 M., 1 l. | .. | 16·65 *t* | 470 / 700 | 302 |
| scout cr. | Chester | 3750 | 420 | 47 | $18\frac{3}{4}$† | 16,000 Nor. turb. | Bath, Me. | 1907 | 1908 | 337,000 | $2-1\frac{1}{2}$ | .. | 4 *5-in.*, 2 *3-in.*, 1 *3-in.* A.A., 4 M. | 2 sub. | 26·5 *t* | 1250 / 1433 | 356 |
| ” <br> ” | *Cincinnati <br> *Concord *Pl. 44.* | 7500 | 550 | 55 | 19† | 90,000 | Tacoma, Wash. <br> Philadelphia (Cramp) | 1921 <br> Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin. | 33·7 | Oil. | 356 |
| p.v. | Cleveland | 3200 | 292 | 44 | 17 | 4640 B.&W. | Bath, Me. | 1901 | 1903 | 212,325 | 2 | .. | 6 *5-in.*, 1 *3-in.* A.A., 2 *1-pr.*, 2 M., 1 l. | .. | 16·4 *t* | 470 / 700 | 302 |
| l. cr. | Columbia | 7350 | 412 | $58\frac{1}{4}$ | $24\frac{1}{2}$ | 18,509 | Philadelphia | 1892 | 1894 | 559,950 | $4-2\frac{1}{2}$ | 4 shield | 3 *6-in.*, 4 *4-in.*, 2 *3-in.* A.A., 4 *1-pr.*, 2 *3-pr.* | .. | 22·8 *t* | 750 / 1670 | 477 |
| p.v. <br> ” | Denver <br> Des Moines | 3200 | 292 | 44 | 17 | 4135 B. & W. | Philadelphia <br> Quincy, Mass. | 1902 | 1904 | 212,325 | 2 | .. | 6 *5-in.*, 1 *3-in.* A.A., 4 *6-pr.*, 2 *1-pr.*, 4 M., 1 l. | .. | 16·65 | 470 / 700 | 303 |
| scout cr. | *Detroit *Pl. 44.* | 7500 | 550 | 55 | 19† | 90,000 | Quincy, Mass. (Bethlehem) | Bldg. | .. | Cost and fee. | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin. | 33·7 | Oil. | 356 |
| p.v. | Galveston | 3200 | 292 | 44 | 17 | 5073 B. & W. | Richmond, Va. | 1903 | 1904 | 212,325 | 2 | .. | 6 *5-in.*, 1 *3-in.* A.A., 4 *6-pr.*, 2 *1-pr.*, 4 M., 1 l. | .. | 16·4 | 470 / 700 | 302 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| scout cr. | *Marblehead | 7500 | 550 | 55 | 19† | 90,000 | Philadelphia (Cramp) | Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin | 33·7 | Oil | 356 |
| ,, | *Memphis *Pl.* 44. | 7500 | 550 | 55 | 19† | 90,000 | Philadelphia (Cramp) | Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin | 33·7 | Oil | 356 |
| ,, | *Milwaukee *Pl.* 44. | 7500 | 550 | 55 | 19† | 90,000 | Tacoma, Wash. | Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin | 33·7 | Oil | 356 |
| *l. cr.* | **Minneapolis** | 7350 | 412 | 58¼ | 24½ | 20,862 | Philadelphia | 1893 | 1894 | 552,754 | 4–2½ | 4 shield | 3 *6-in.*, 4 *4-in.*, 2 *3-in.* A.A., 2 *1-pr.*, 2 M. | .. | 23·0 *t* | 750 / 1433 | 477 |
| ,, | **New Orleans** | 3847 | 346 | 43¾ | 19 | 7500 | Elswick | 1896 | 1898 | 293,684 | .. | 3–1¼ shields | 8 *5-in.*, 1 *3-in.* A.A., 2 *3-pr.*, 2 *1-pr.*, 4 M. | .. | 20·0 | 512 / 767 | 366 |
| scout cr. | *Omaha | 7500 | 550 | 55 | 19† | 90,000 | Tacoma, Wash. | 1920 | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | twin 2 | 33·7 | Oil | 356 |
| ,, | *Raleigh | 7500 | 550 | 55 | 19† | 90,000 | Quincy, Mass. | Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | twin 2 | 33·7 | Oil | 356 |
| ,, | *Richmond *Pl.* 44. | 7500 | 550 | 55 | 19† | 90,000 | Philadelphia (Cramp) | 1921 | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | twin 2 | 33·7 | Oil | 356 |
| *p.v.* | **Sacramento** | 1425 | 225 | 40¾ | 11½ | 1022 | Philadelphia | 1913 | 1914 | 101,200 | .. | .. | 3 *4-in.*, 2 *3-pr.*, 2 M., 2 l. | .. | 12·8 *t* | 428 | 156 |
| scout cr. | **Salem** | 3750 | 420 | 47 | 18¾ | 22,242 W.T. turb. | Quincy, Mass. | 1907 | 1908 | 301,000 | 2–1½ | .. | 4 *5-in.*, 2 *3-in.*, 1 *3-in.* A.A., 2 M. | 2 sub. | 25·9 *t* | 1250 / 1433 | 356 |
| *p.v.* | **Tacoma** | 3200 | 292 | 44 | 17 | 5288 B.&W. | S. Francisco | 1903 | 1904 | 212,325 | .. | 2 shields | 6 *5-in.*, 1 *3-in.* A.A., 4 *6-pr.*, 2 *1-pr.*, 4 M. | .. | 16·6 *t* | 470 / 700 | 302 |
| sc. cr. | *Trenton *Pl.* 44. | 7500 | 550 | 55 | 19† | 90,000 | Philadelphia (Cramp) | Bldg. | .. | Cost and fee | .. | .. | 12 *6-in.*, 2 *14-pr.* A.A., 2 *3-pr.* | 2 twin | 33·7 | Oil | 356 |

§ Prices exclusive of armament. † Mean draught.

Patrolling and gun vessels Helena, Nashville, Newport, Vicksburg, Wheeling, and Wilmington, 1000 to 1392 tons, launched 1895–97: thirteen others and 10 patrolling yachts. Aircraft carriers Langley (*ex* collier Jupiter) and Wright (converted merchantman, 14,240 tons, 4 *5·5-in.* guns). Mine-layers Aroostook, Baltimore, San Francisco, and Shawmut, carrying 5-in., and small anti-aircraft guns. A large flotilla of mine-sweepers and tugs. Submarine tenders Albert, Beaver, Bushnell, Camden, Fulton, Holland, Rainbow, and Savannah. Destroyer depôt ships Black Hawk, Buffalo, Dixie, Dobbin, Leonidas, Meville, Panther, Prairie, and Whitney. Repair ships Topeka, Villalobos, Bridgeport, 7594 tons, Medusa, 10,000 tons, Prometheus and Vestal, 12,595 tons. Radio repair ship Saturn. Hospital ships Comfort, Mercy, Relief, and Solace. Ulysses and Achilles, colliers, for the Panama Canal. Twelve other colliers and 13 oilers. River gunboats Monocacy and Palos, completed 1914.

Training ships Olympia, 5870 tons; Chicago, 4500 tons; Anniston (*ex* Marblehead), 2089 tons. Torpedo experimental vessel Montgomery, 2089 tons.

The ocean liners St. Louis and St. Paul, 11,629 tons, New York and Philadelphia, 10,802 tons, 20 knots (International Navigation Co.), and the Korea and Siberia, 11,200 tons, 18 knots (Pacific Mail Steamship Co.) are enrolled auxiliary cruisers.

# SHIPS OF THE LESSER NAVIES.

**Belgium.**—The maritime affairs of Belgium are at present administered in association with the internal railway organisation, but a Naval Commission has been formed, and it is intended to purchase some sloops and other small vessels. The nucleus of a Navy consists of the sloop *ex* Zinnia 16 knots, one 4·7-in. and two 12-prs., and the torpedo boats A1, 2, and 3, left by the Germans in Belgian harbours, with a couple of small submarines.

**Bulgaria.**—Under the terms of the naval clauses of the Peace Treaty, Bulgarian warships of all classes, existing or under construction, were surrendered to the Allied and Associated Powers or broken up, as well as all naval arms, munitions, and war material. No submarines may be built or acquired even for commercial purposes.

**China.**—The principal vessels of the Chinese Navy have been built in England. The Cha-Ho and Ying-Swei are cruisers of 2600 tons, completed respectively at Elswick and Barrow in 1912. With turbine engines of 6500 H.P., they had a speed of 22 knots. There is ¾-in. deck protection; armament, two 6-in., four 4-in., two 12-pr. and some smaller guns, with two torpedo tubes. The Hai-Chi (Elswick, 1899) displaces 4300 tons, and with 17,000 H.P. is given a speed of 24 knots; armament, two 8-in., ten 4·7-in., twelve 12-pr., and ten smaller guns; five torpedo tubes. The cruisers Hai-Shen, Hai-Chew, and Hai-Yung, 2954 tons, were completed by the Vulkan Company at Stettin in 1898. They attained 20·7 knots on trial (7500 H.P.); armament, three 6-in., eight 4-in., twelve machine guns, three torpedo tubes, of which one submerged. For the Yangtsze are the gun-vessels Kiang-Wei and Kiang-An, 871 tons, one 3·9-in. and smaller guns, built at Foochow in 1892; the Yung-Fang, Yung-Kien, Yung-Chon, Yung-Tsih, similar vessels built in Japan and at Kiang-Nan; six others built at Kobe (two 4·7-in.), four smaller (550 tons, one 4·7-in.), two smaller (150 tons), and seven light draught gunboats. Also the Li-Sui (260 tons, 14 knots), and Li-Chi (220 tons, 13 knots), *ex* German river gunboats. Three small destroyers (400 tons, 35 knots, two 12-pr., four 3-pr., 2 tubes). Tung-An, Yu-Chang, Kien-Kon, were built at Elbing in 1912; torpedo-boats, Chen-Suh (120 tons, two 3-pr., three tubes, 20 knots (Stettin, 1907), and twenty-one smaller boats. Two submarines of the Medusa type were under construction in Italy in 1921.

**Colombia.**—Cruiser Almirante Lezo (*ex* El Baschir), 1200

tons; 2500 H.P.; 18 knots; built 1892, bought from Morocco. Gunboats, Chercinto and Bogota. River gunboats, General Nerino and Esperanza, 400 tons. Three Yarrow motor gunboats, 1913.

**Cuba.**—Cruiser, Cuba, 2055 tons, 3500 H.P. 18 knots, and Patria, 1220 tons, 16 knots, also four gunboats.

**Ecuador.**—The torpedo cruiser Almirante Simpson, 812 tons, bought from Chili. One torpedo-boat and two transport vessels.

**Egypt.**—Sloop (*ex* Syringa), 1918, 1310 tons, 17 knots, two 4-in. guns. Nile stern-wheel gunboats Sultan, Sheikh, and Melik, 140 tons, Zafir, Fateh and Naseh, 128 tons; also the Abu Klea, Hafir, Metemmeh, and Tamai.

**Esthonia.**—With small but efficient naval forces the young Navy of Esthonia gallantly assisted the operations of Sir Walter Cowan, whereby the independence of Esthonia was secured. Rear-Admiral Johan Pitka was in command, and in token of the happy association King George conferred upon that officer the K.C.M.G. The Navy consists of destroyers Wambola (*ex* Kapitan Kingsbergen), 1600 tons, 29 knots, four 4-in. guns, 2 M, 9 T.T., and Lennuk (*ex* Autroil), 1800 tons, 32 knots, five 4-in. guns, and one 12-pr., 9 T.T., with gunboats, launches and some other vessels, including the *ex* Russian gunboat Bobr, 875 tons, two 4·7-in. and four 12-pr. guns, completed in 1908, which has received the name of Lembit. Two mine-layers.

**Finland.**—The Finnish Navy is undergoing some development. The *ex* Russian gunboat Gilyak, 875 tons, two 4·7-in. and four 12-pr. guns, has been transferred to it; also Klas Horn (*ex* Posadnik), Matti Kurki (*ex* Voevoda), Karjala (*ex* Filin), and Turunmaa (*ex* Orlan), with 2 mine-layers, and 2 trawlers.

**Hayti.**—Gunboat—Capois la Mort, 260 tons, one 3·9-in., and four 1-pr. Q.F. Iron corvette—Dessalines, 1200 tons. Two sloops—St. Michael and 1804. Gun-vessel, 22nd of December. Umbria, old cruiser, of 2245 tons.

**Jugo-Slavia.**—The Powers allotted to Jugo-Slavia 12 *ex* Austro-Hungarian torpedo-boats—F 87, 93, 96, 97, 69, T 54, 60, 61, and 76 to 79—to be used solely for police purposes. In addition the French left at Cattaro two old Austrian ironclads and several other vessels of no great value. On the Danube is the former Austrian monitor Bodrog, built in 1904, 440 tons, 1400 H.P., 13 knots, two 4·7-in. guns., one 4·7-in. howitzer, and three machine guns. The Jugo-Slavs claimed other vessels in the river, but three gunboats have been handed over by them to Roumania.

**Mexico.**—Two gun-vessels, Tampico and Vera Cruz (Elizabethport, New Jersey, 1902); displacement, 980 tons; armament, 4 4-in. Q.F., 6 6-pr.; 16 knots; fitted to serve as transport for 200 troops. Gun vessels Bravo and Morero, 1200 tons; 2600 I.H.P.; 17 knots; (Leghorn, 1904). Zaragoza, 1200 tons, 1300 H.P., 15 knots, 4 4·7-in. and 4 small Q.F. Torpedo transport General Guerrero, 1880 tons; completed at Barrow 1908. Two small gunboats of 10 knots speed. Five torpedo-boats.

**Peru.**—Almirante Grau and Coronel Bolognesi, cruisers, 3200 tons; (Barrow, 1906); 2 6-in., 8 14-pdr., 8 1¼-pdr.; 2 submerged torpedo tubes; 24 knots. Armoured cruiser Dupuy de Lôme, purchased for £140,000, and renamed Elias Aguirre. Destroyer, Rodriguez, 500 tons, and submarines, Ferré and Palacios, built Le Creusot, 1912–13. Three submarines are building in Italy (Ansaldo). Screw steamer, Santa Rosa, about 400 tons.

**Poland.**—The Polish Government hopes eventually to become possessed of a small Navy. The British Mission, under direction of Commander E. L. Wharton, R.N., which advised the Polish authorities on the organisation of docks, the direction of maritime traffic, mine-sweeping, river police, and the like, has been withdrawn. It is proposed that Poland shall be allowed six small cruisers and gunboats on the Vistula. She has been allotted six *ex* German torpedo boats for police purposes. The first of the gunboats, Marshal Pilsudski, 500 tons, carrying several small guns, was built in Finland. Another is under construction.

**Portugal.**—The most considerable vessel in the Portuguese Navy is the cruiser Almirante Reis, completed at Elswick in 1899; 4100 tons, 12,000 H.P.; four 5·9-in., eight 4·7-in., fifteen smaller guns, five tubes; 22 knots. The Adamastor, 1962 tons, completed at Leghorn in 1897, and the São Gabriel at Havre in 1899, have as their chief armament, two 5·9-in. and four 4·7-in. guns. The Dom Luiz, Save, Patria, and Lurio are gunboats for Mozambique and Timor. The mine-layer Vulcano was built by Messrs. Thornycroft in 1909. There are other small boats, and several sloops sold out of the British Navy are being added. These are the Republica (*ex* Acacia), and Carvalho Aronjo (*ex* Jonquil), also the Anemone, Jessamine, and Camellia. Portugal has the old destroyer Tejo and four modern, Douro, Guadiana, Vouga, and Tamega (1912–18), 700 tons, 11,000 H.P., 20 knots, two tubes, also six *ex* Austrian F boats for police duties. Submarines Espadarte, 245–300 tons, 13 knots (F.I.A.T.), and Foca, Golfinho, and Hidra (Laurenti); 260–389 tons, 13–8·5 knots, 2 T.T.

**Roumania.**—Elizabeta, protected cruiser (deck 3 in.), built in 1887 at Elswick; 230 ft. long, 32 ft. 10 in. beam; 1320 tons; 3000 I.H.P.; armament, 4 5·9-in. B.L.R., 4 Q.F., 2 M., 4 torpedo tubes. For the Danube, the gunboats Fulgurul, Oltul, Siretul, Bistritza 90 to 100 tons, Alexandru cel Bun, 104 tons (now a school ship), 9 sloops, and the river monitors Lascar Catargi, Ion Bratianu, Mihail Kogalniceanu, and Alexandro Lahovary (600 tons), 3 4·7-in. guns. Two destroyers Naluka and Sborul, built at Havre, 1888; 578 tons, two torpedo tubes, 21 knots. Four destroyers built at Naples, 1350–1450 tons, of which two have been commissioned. Seven 100-ft. torpedo-boats built on the Thames; four by Schichau, 1904, for the Danube: Vedea, Argosul, Trotosul, Teleorman; four others, and seven ex-Austrian F and T torpedo boats for police duties.

**Russia.**—The tables of the Russian battleships and light cruisers appeared in the Naval Annual of 1919, at pp. 322–25, and of the flotillas at pp. 365–66. The Russian naval forces are completely disorganised, and no definite statement can be made regarding them. Some notes on the present situation will be found in Chapter II. The Soviet Government has shown great power of organisation and administration in military concerns, and is not likely to underestimate the value of the naval forces however much mutiny and sabotage may have damaged them.

In the Baltic the four battleships Gangut, Poltava, Petropavlovsk, and Sevastopol, 23,000 tons, twelve 12-in. guns, 18 knots, launched in 1911, completed in 1915, now exist in no efficient condition. The battle-cruisers Borodino, Ismail, Kinburn, and Navarin, 32,000 tons, twelve 14-in. guns, 27 knots, though launched, are not likely to be completed. The older battleships Andrei Pervozvannyi, Grazhdanin, Respublika and Chesma, each four 12-in. guns, appear to be useless, and there are the armoured cruisers Gromoboi, Rossia, Rurik, Bayan, and Admiral Makaroff. The Soviet Government also disposes of the light cruisers Aurora, Bogatyr, Boutakoff, Diana, Grieg, Oleg, Spiridoff, and Svietlana. There are several river gunboats. The gunboat Bobr has passed to Esthonia, and the Gilyak to Finland, as well as several other vessels.

The Soviet Government possessed about fifty destroyers in the Baltic, thirty of them built in and since 1914.

The list of submarines in the Baltic is subject to doubt. With few exceptions, including the Kassatka, Makrel, Okun, and Minoga, all the former flotilla disappeared. On the other hand, fourteen submarines built between 1914 and 1917 have been added. These are the Zmieya, Yaz, Forel, Yersh, Volk, Vepr, Keta, Kuguor, Leopard, Pantera, Ruis, Tigr, Tur, and Yaguar. They are from 220 to

223 feet long, with 14 ft. 6 in. beam and 12 ft. 7 in. draught, 650–784 tons displacement, 500–840 H.P., 10–9 knots, 40 tons oil-fuel, and four torpedo tubes and dropping gear. The four first named have greater H.P. and surface speed, 2640–900 and 16–9 knots. The Sviatoi Georg is also named.

In the Black Sea, among the naval forces controlled by General Wrangel, very serious damage was done to the most powerful ships by elements hostile to the *de facto* Government. On April 25, 1919, by explosive means, the main engines were wrecked or destroyed of the five battleships Sviatoi Evstafi, Ioann Zlatoust, Rostislav, Boretz za Svobodu, and Tri Sviatitelia. The heavy guns were removed from the old battleships, and from the injured ships or some of them, and were sent up to the front of the Armies. In Chapter II. particulars will be found of the internment of Wrangel's fleet at Bizerta in French charge. The battleship Demokratiya has not yet been completed.

There were in the Black Sea about 20 destroyers, of which the Cerigo, Korfu, Lesbos, and Zante (1345 tons, 33 knots), were built between 1914 and 1916. Of the submarines only two remain, the Nerpa and Tiulen. On the other hand, six submarines have been built, of which four controlled by General Wrangel arrived at Bizerta. These appear to have been the Utka, 650–784 tons, 500–900 H.P., 10–9 knots, fuel 40 tons, four torpedo tubes; the Borgevestnik, 2640–900 H.P., 16–9 knots, same armament; the A.E. 22, of which the details were unknown, and one other. The Bolshevists held the A.E. 23, now named Trotsky, and also two sisters of the Borgevestnik class, named Lebed and Pelikan, which were sunk in Odessa harbour. The Sviatoi Georgi is a new submarine. Some of the Soviet submarines appeared in the Black Sea.

**Santo Domingo.**—The Independencia, built in England 1894, 322 tons, seven Hotchkiss Q.F. Restauracion, gun-vessel, 1000 tons, launched at Glasgow in 1896. The 14-knot cruiser Presidente has been reconstructed, and carries seven guns.

**Sarawak.**—Two gunboats, of 175 and 118 tons respectively.

**Siam.**—Old protected cruiser Maha Chakrkri, 2500 tons, 17 to 18 knots; four 4·7-in. and ten 6-pdr. Q.F. Makut-Rajakamar, 650 tons. The gunboats Bali, Muratha, and Sugrib, 600 tons, one 4·7-in. Q.F., five 2·2 in., four 1·4 in., 12 knots, launched 1898 and 1901. Several other gunboats. Three modern despatch vessels 100 to 250 tons. Three 380-ton, 27-knot destroyers, built at Kobe. Phra Ruan (*ex* British destroyer Radiant, 1917). Three torpedo-boats, 120 tons, 22 knots.

**Uruguay.**—Torpedo-cruiser Uruguay, built at the Vulcan Yard, Stettin; 1400 tons; two 4·7-in., four 12-pdr., twelve Maxims; two 18-in. torpedo tubes; 5700 I.H.P.; 23 knots. Old gunboats; General Artigas, 274 tons, 12½ knots, two 4·7-in., two M.; and General Saurez, 300 tons.

**Venezuela.**—Gunboats Bolivar, 571 tons, 18·6 knots, and Miranda, 200 tons, 12 knots; transports Restaurador, 568 tons, and Zamora, 350 tons. Marescal Sucre (*ex* Isla de Cuba), drill ship bought from United States, 1912.

# BRITISH AND FOREIGN FLOTILLAS.

## Great Britain.

| Name or Number. | Built by. | Completed. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Horse-Power. | Mean Speed on Trial, or expected. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FLOTILLA LEADERS. | | | | | | | | | | |
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| *Abdiel | Cammell Laird | 1916 | | | | | | | | | | | |
| Ithuriel | | | | | | | | | | | | | |
| Parker | | | | | | | | | | | | | |
| Grenville | | | 315 | 31·9 | 10 | 3 | 1610 to 1680 | 36,000 | 34 | 4-4 in. Q.F. 2-2 prs. | 4 | 110 to 116 | Oil. 515 |
| Seymour | ,, ,, | 1916 | | | | | | | | | | | |
| Saumarez | | | | | | | | | | | | | |
| Nimrod | Denny | 1917 | | | | | | | | | | | |
| Valkyrie | ,, | | | | | | | | | | | | |
| Valorous | ,, | | | | | | | | | | | | |
| Valentine | Cammell Laird | 1917 | 300 | 29·6 | 9 | 2 | 1320 to 1340 | 27,000 | 34 | 4-4 in. Q.F. 1-3 in. A.A. | 4 | 116 | Oil. 367 |
| Valhalla | ,, ,, | | | | | | | | | | | | |
| Vampire | J. S. White | | | | | | | | | | | | |
| Shakespeare | Thornycroft | 1917 | | | | | | | | | | | |
| Spenser | ,, | 1917 | | | | | | | | | | | |
| Wallace | ,, | 1919 | 318 | 31·9 | 10·6 | 2 | 1750 | 43,500 | 36·5 | 5-4·7 in. 1-3 in. A.A. | 6 | 164 | Oil. 500 |
| Keppel | ,, | Bldg. | | | | | | | | | | | |
| Broke, *ex* Rooke | ,, | Bldg. | | | | | | | | | | | |
| Bruce | | | | | | | | | | | | | |
| Douglas | | | | | | | | | | | | | |
| Campbell | Cammell Laird | 1918 | | | | | | | | | | | |
| Mackay, *ex* Claverhouse | | | 320 | 31·9 | 10·6 | 2 | 1800 | 44,000 | 36·5 | 5-4·7 in. 1-3 in. A.A. | 6 | 164 | Oil. 500 |
| Malcolm | | | | | | | | | | | | | |
| Montrose | Hawthorn | 1918 | | | | | | | | | | | |
| Stuart *Pl.* 16. | ,, | 1919 | | | | | | | | | | | |

*** Fitted as mine-layer. To be removed from effective list.**

### TORPEDO BOAT DESTROYERS.

"*R*" *Class*:—Rapid, Ready, Retriever, Rosalind, Taurus, Teazer (Thornycroft); Relentless, Rival, Sabrina, Sybille, Truculent Tyrant (Yarrow); Radstock, Raider, Sorceress, Torrid, Tower (Swan, Hunter); Redgauntlet, Rob Roy, Rocket (Denny); Redoubt, Umpire (Doxford); Restless, Rigorous, Romola, Rowena, Simoom, Skate, Tarpon, Telemachus (John Brown); Salmon, Sylph, Skilful, Springbok, Tenacious, Tetrarch (Harland and Wolff); Sable, Trenchant (White); Sarpedon, Starfish, Stork, Thisbe, Thruster (Hawthorn); Satyr, Sharpshooter, Tancred, Ulster (Beardmore); Sceptre, Sturgeon, Tormentor (Stephen); Tempest, Undine (Fairfield); Urchin, Ursa (Palmer); Ursula (Scotts).

Displacement, 883–1040 tons; length, 260–265 ft.; 26,500–27,000 H.P.; speed, 35–36 knots; armament, three 4-in., one 2-pdr., four torpedo tubes; fuel, 256–300 tons; complement, 82.

"*S*" *Class*:—Sabre, Saladin, Sardonyx (Stephen); Scimitar, Scotsman, Scout, Scythe, Seabear, Seafire, Searcher, Seawolf (John Brown); Senator, Sepoy, Seraph, Serapis, Serene, Sesame (Denny); Shamrock, Shikari (Doxford); Shark, Sparrowhawk, Splendid, Sportive, Tilbury, Tintagel (Swan, Hunter); Steadfast, Stirling, Stormcloud (Palmers); Strenuous, Stronghold, Sturdy, Swallow (Scotts); Tactician, Tara (Beardmore), Tenedos, Thanet, Thracian, Turbulent (Hawthorn); Speedy, Tobago, Torbay, Toreador, Tourmaline, (Thornycroft); Tribune, Trinidad, Trojan, Truant, Trusty (White); Torch, Tomahawk, Tumult, Turquoise, Tuscan, Tyrian (Yarrow).

Displacement, 885–1090 tons; length, 260–265 ft.; 27,000 H.P.; speed, 36 knots; armament, three 4-in., one 2-pdr., six torpedo tubes; fuel, 250–300 tons; complement, 90.

"*V*" *Class*:—Vancouver, Vanessa, Vanity (Beardmore); Vanoc, Vanquisher (J. Brown); Vectis, Vortigern (White); Vega, Velox (Doxford); Vendetta, Venetia (Fairfield); Venturous (Denny); Verdun, Versatile (Hawthorn); Vesper, Vidette (Stephen); Viceroy, Viscount (Thornycroft); Violent, Vimiera (Swan, Hunter); Vivacious, Vivien (Yarrow).

Displacement, 1275–1300 tons; length, 300 ft.; H.P., 27,000–30,000; speed, 34–35 knots; armament, four 4-in., one 3-in., four torpedo tubes; fuel, 367 tons; complement, 110.

"*W*" *Class*:—Voyager (Stephen); Wakeful, Watchman, Venomous, Verity, Veteran (J. Brown); Walker, Westcott, Volunteer (Denny); Walpole, Whitley (Doxford); Walrus, Wolfhound, Wanderer (Fairfield); Warwick, Wessex (Hawthorn); Westminster (Scotts); Wolsey, Woolston, Wishart, Witch (Thornycroft); Vansittart (Beardmore); Winchelsea, Winchester, Witherington, Wivern, Wolverine, Worcester (White); Whirlwind, Wrestler, Whitehall, Whitshed, Wild Swan (Swan, Hunter); Waterhen, Wryneck (Palmers); Wren (Yarrow).

Displacement, 1275–1350 tons; length, 300 ft.; H.P., 27,00 ; speed, 34 knots; armament, four 4-in., or four 4·7-in., and one 3-in.; six torpedo tubes; fuel, 365 tons; complement, 127.

### SLOOPS.

Of the large number of sloops which were built during the War for patrol and other duties only about twenty now remain in the Post-War Fleet, some in commission abroad and others for subsidiary and training duties in home waters.

Names are as follow: Bluebell, Camellia, Clematis, Cornflower, Chrysanthemum, Crocus, Cyclamen, Daffodil, Delphinium, Foxglove, Godetia, Harebell, Heather, Heliotrope, Hollyhock, Laburnum, Lily, Lupin, Magnolia, Snapdragon, Valerian, Verbena, Veronica, Wallflower, Wistaria. Also Petersfield (*ex* mine-sweeper).

Displacement, 1250 tons; length, 255 ft.; H.P., 2400; speed, 17 knots; armament, two 4-in., two 3-pdrs.; 260 tons of coal; complement, 93.

### TWIN-SCREW MINE-SWEEPERS.

The following are retained in the Post-War Fleet:—

Alresford, Carstairs, Caterham, Sherborne, Mistley, Burslem, Truro, Badminton, Tring, Leamington, Albury, Caerleon, Camberley, Dorking, Dundalk, Dunoon, Elgin, Faversham, Fermoy, Ford, Forres, Gaddesden, Gainsborough, Gretna, Irvine, Kendal, Lydd, Mallaig, Malvern, Marlow, Meynell, Munlochy, Nailsea, Newark, Northolt, Pangbourne, Prestatyn, Ross, Rugby, Saltash, Saltburn, Selkirk, Shrewsbury, Stafford, Sutton, Swindon, Tiverton, Tonbridge, Tralee, Weybourne, Yeovil.

Most of the foregoing form a "Central Reserve of Twin-Screw Mine-sweepers." In addition, the following are employed on surveying duties:—

Beaufort, Collinson, Crozier, Fitzroy, Flinders, Kellet.

Displacement, 800 tons; length, 220 ft.; H.P., 2200; speed, 16 knots; armament, one 3-pdr.; 140 tons of coal; complement, 74.

PATROL BOATS.

The following are retained in the Post-War Fleet:—

P 31, P 38, P 40 P 46, P 47, P 48, P 52, P 59, PC 43, PC 56, PC 60, PC 70, PC 71, PC 72, PC 73, PC 74.

Displacement, 573 tons; length, 230 ft.; H.P., 4000; speed, 22 knots; armament, one 4-in., one 2-pdr., two 14-in. tubes; oil, 93 tons; complement, 54.

SUBMARINES.

"*E*" *Class*:—E 23, E 27, E 31, E 32, E 33, E 35, E 38, E 41, E 42, E 45, E 46, E 48, E 53, E 55.

Surface displacement, 660 tons, submerged, 800; surface H.P., 1600, submerged, 840; surfacee speed, 15 knots, submerged, 10 knots; oil, 45 tons; armament one 3-in., five 18-in. tubes; complement, 30.

"*G*" *Class*:—G 3, G 4, G 5, G 6, G 10, G 13.

Surface displacement, 700 tons, submerged, 975; surface H.P., 1600, submerged, 840; surface speed, 14 knots, submerged, 10 knots; oil, 44 tons; armament, one 3-in., four 18-in., and one 21-in. tubes; complement, 30.

"*H*" *Class*:—H 21, H 22, H 23, H 24, H 25, H 26, H 27, H 28, H 29, H 30, H 31, H 32, H 33, H 34, H 42, H 43, H 44, H 47, H 48, H 49, H 50, H 51, H 52.

Surface displacement, 440 tons, submerged, 500; surface H.P., 480, submerged, 320; surface speed, 13 knots, submerged, 10½ knots; oil, 16 tons; armament, four 21-in. tubes; complement, 22.

"*K*" *Class*:—K 2, K 6, K 12, K 14, K 15, K 22. Building, K 26.

Surface displacement, 1880 tons, submerged, 2650; surface H.P., 10,000, submerged, 1400; surface speed, 24 knots, submerged, 9 knots; oil, 200 tons; armament, one 4-in., one 3-in. A.A., eight 18-in. tubes; surface propulsion by steam turbines; complement, 54.

"*L*" *Class*:—L 1, L 2, L 3, L 4, L 5, L 6, L 7, L 8, L 9, L 11, L 12, L 14, L 15, L 16, L 17, L 18, L 19, L 20, L 21, L 24, L 25, L 33, L 52, L 56, L 71. Building, L 22, L 23, L 26, L 27, L 53, L 54, L 69.

Surface displacement, 890 tons, submerged, 1070; surface H.P., 2400, submerged, 1600; surface speed, 17½ knots, submerged, 10½ knots; oil, 76 tons; armament, one 3-in. or 4-in., six 18-in. tubes. (L 52 and later boats have two 4-in. guns each.); complement, 38.

"*M*" *Class*:—M 1, M 2, M 3. Details not published. One 12-in. gun; complement, 65.

"*R*" *Class*:—R 1, R 2, R 3, R 4, R 7, R 8, R 9, R 10, R 11, R 12.

Surface displacement, 420 tons, submerged, 500; surface H.P., 1200, submerged 240; surface speed, 15 knots, submerged, 9½ knots; oil, 13 tons; complement, 22.

## Argentine Republic.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Corrientes .. .. | Yarrow .. | 1896 | 190 | 19·6 | 7·4 | 2 | 280 | 4,000 | 27·4 *t.* | 1 14-pr. | 3 | 54 | 80 |
| Misiones.. .. .. | Yarrow .. | 1896 | 190 | 19·6 | 7·4 | 2 | 280 | 4,000 | 26·0 *t.* | 3 6-pr, | 3 | 54 | 80 |
| Entre Rios .. .. | Yarrow .. | 1896 | 190 | 19·6 | 7·4 | 2 | 280 | 4,000 | 26·7 *t.* | Q.F., 2 M. | 3 | 54 | 80 |
| Catamarca, Jujuy .. | Germania .. | 1911 | 286·7 | 27·1 | 8·6 | 2 | 940 | 18,000 | 32 | 4 4-in. | 4 | 110 | 250* |
| Cordoba, La Plata .. | Schichau .. | 1911 | 279 | 29·6 | 7·3 | .. | 890 | 19,000 | 34·7 | 4 4-in. | 4 | 110 | 290* |
| FIRST CLASS— | | | | | | | | | | | | | |
| 2 boats .. .. .. | Thornycroft | 1890–1 | 150 | 14·5 | 5·2 | 2 | 110 | 1,500 | 24·52 | 3 3-prs. | 3 | 27 | 22 |
| 6 boats .. .. .. | Yarrow .. | 1890 | 130 | 13·5 | 6·0 | 1 | 85 | 1,200 | 23–24 | 2 3-pr. Q.F. | 2 | 15 | 15 |

The two 150-ft. boats are named Comodoro Py and Murature.
The six 130-ft. boats are named Bathurst, Buchardo, Jorge, King, Pinedo, and Thorne.
* Also oil fuel 50–110 tons.

## Brazil.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Para .. .. .. .. | | 1908 | | | | | | 7,014 | 27·25 | | | | |
| Amazonas .. .. | | 1908 | | | | | | 6,898 | 27·17 | | | | |
| Piahuy .. .. .. | | 1908 | | | | | | 6,563 | 27·21 | | | | |
| Matto Grosso .. .. | | 1908 | | | | | | 7,403 | 27·16 | | | | |
| Parahyba.. .. .. | Yarrow .. | 1909 | 240 | 23·6 | 10 | 2 | 550 | 6,700 | 27·29 | 2 4-in., 4 3 prs. | 2 | .. | 140 |
| Rio Grande do N. .. | | 1909 | | | | | | 7,778 | 27·27 | | | | |
| Alagoas .. .. .. | | 1909 | | | | | | 7,403 | 27·25 | | | | |
| Santa Catharina .. | | 1909 | | | | | | 6,982 | 27·30 | | | | |
| Parana .. .. .. | | 1910 | | | | | | 8,877 | 28·74 | | | | |
| Sergipe .. .. .. | | 1909 | | | | | | 8,554 | 27·60 | | | | |
| FIRST CLASS— | | | | | | | | | | | | | |
| Goyaz .. .. .. | Yarrow .. | 1907 | 152·5 | 15·3 | .. | 3 | .. | .. | 26·5 | 2–3 prs. | 2 | .. | .. |
| SUBMARINES— | | | | | | | | | | | | | |
| F 1, 3, 5 .. .. .. | Muggiano (Fiat) | 1914 | 150 | 14 | 9·8 | .. | 250–375 | .. | 14–8·5 | .. | 2 | .. | .. |

Five additional destroyers and three submarines are in the programme.
Six *ex*-enemy torpedo-boats were allotted to Brazil, to be used for police purposes. A Laurenti submarine salvage and testing vessel, named Caera, 3800 tons, 328 ft. long, 59 ft. beam, 14 knots.

## Chile.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Almirante Lynch, Condell.. .. .. | White.. .. | 1912, 1913 | 320 | 32·6 | 11·1 | 3 | 1850 | 27,000 | 31·7 | 6–4-in. 2 M. | 4 | .. | 507 |
| Almirante Riveros (*ex*-Broke) .., Almirante Uribe (*ex*-Faulknor) .., Almirante Williams (*ex*-Botha) .. .. | White .. | 1914 | 320 | 32·6 | 11 | 3 | 1700 to 1740 | 30,000 | 31·5 | 2–4·7-in., 2–4-in., 1 6-pr. | 4 | 160 | 486 |
| Tome, Talcahuano* | Laird .. .. | 1898 | 238·8 | 27·9 | 9·8 | — | 750 | 4,500 | 20 | 3-3·8-in., 4-3-pr. | 5 | .. | 100 |
| Capitan Orella .. | Laird .. .. | 1896 | 210 | 21·6 | 5·4 | 2 | 300 | 6,000 | 30·17 | 1-12 pr. Q.F. 5-6 pr. | 2 | 65 | 90 |
| Capitan Muñoz Gamero.. .. .. | Laird .. .. | 1896 | 210 | 21·6 | 5·4 | 2 | 300 | 6,000 | 30·42 | 1-12 pr. Q.F. 5-6 pr. | 2 | 65 | 90 |
| Teniente Serrano .. | Laird .. .. | 1896 | 210 | 21·6 | 5·4 | 2 | 300 | 6,000 | 30·35 | 1-12 pr. Q.F. 5-6 pr. | 2 | 65 | 90 |
| Guardia-Marina Riquelme .. .. | Laird .. .. | 1896 | 210 | 21·6 | 5·4 | 2 | 300 | 6,000 | 30·09 | 1-12 pr. Q.F. 5-6 pr. | 2 | 65 | 90 |
| Capitan Merino Jarpa .. .. .., Capitan O'Brien .. | Laird .. .. | 1901 | 210 | 21·6 | 5·4 | 2 | 350 | 6,000 | 30 | Do. | 2 | 65 | 90 |
| Captain Thompson.. | Armstrong . | 1902 | .. | .. | .. | 2 | 480 | 5,600 | 28 | 6–6 pr. | 2 | 83 | 90 |
| FIRST CLASS— | | | | | | | | | | | | | |
| Injeniero Hyatt, Cirujano Videla, Guardia-Marina Contreras .. .. .. .. | Yarrow .. | 1896, 1898 | 152·6 | 15·3 | 7·9 | 1 | 140 | 2,200 | 27·5 27·2 | 3-3 pr. Q.F. | 3 | 28 | 40 |

* Depots for submarines.

Six submarines (Holland type) built for the British Government in 1915 were ceded to the Chilian Navy in 1917. They are numbered H 1 to H 6; 450–520 tons, 960–620 H.P., 13–11 knots, length 150 feet, 1 gun, 4 T.T.

## Denmark.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIRST CLASS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons |
| Havkatten, Sælen .., Nord Kaperen.. .., Makrelen .. .. .., Narhvalen .. .., Havhesten, Söhunden, Sölöven, Stören .., Springeren .. .. | Royal Dockyard, Copenhagen | 1919, 1918, 1918, 1917, 1917, 1916, 1916 | 126·3 | 13·9 | 8·4 | 2 | 108·5 | 2,000 | 24·6 | 2 6-pr. A.A. | 2 | 22 | 15 |
| Ormen .. .. .. | Royal Dockyard, Copenhagen | 1907 | 124·6 | 14·3 | 8·5 | 1 | 105 | 2,100 | 26 | 2 1-pr. | 3 | 21 | 11 |
| Sværdfisken .. .., Delfinen, Hvalrossen | Royal Dockyard, Copenhagen | 1913, 1913 | 148·2 | 16·9 | 7·5 | 2 | 190 | 3,480 | 26·2 | 1 6-pr. | 4 | 30 | 28 |
| Soülven .. .. .., Feyvefisken .. .. | Burmeister, Copenhagen | 1911, 1911 | 181·7 | 18 | 9·7 | 2 | 275 | 5,000 | 27·5 | 2 12-pr. | 5 | 33 | 55 |
| Soridderen .. .. | Yarrow & Co. | 1911 | | | | | | | | | | | |
| Spaekhuggeren .., Vindhunden .. .. | Royal Dock., Copenhagen | 1911 | 184·8 | 19·1 | 7·1 | 2 | 300 | 5,000 | 27·5 | 2 12-pr. | 5 | 34 | 49 |
| Tumleren.. .. .. | Schichau | | | | | | | | | | | | |

Three old torpedo boats rebuilt, 1902–8.

SUBMARINES—Bellona, Flora, Rota, 301–369 tons, 1 2·2-in. A.A., 4 T.T. Galathea, Neptun, Triton, Ran, Ægir, 185–235 tons, 13·5 9·8 kts., 1 2·2-in. A.A., 3 T.T. Nymfen, Najaden, Havfruen, Havmanden, Thetis, An den April, 167–204 tons, 13·5 8 kts., 2 M., 2 T.T.

## France.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Bouclier .. .. .. .. .. | Normand .. | 1911 | 237·0 | 24·9 | 9·4 | 3 | 790 | 13,000 | 35·33 | 2-25-pr.4-9pr. | 4 | 62 | 160 |
| Carquois .. .. .. .. .. | Rochefort .. | 1907 | 197·4 | 21·5 | 11·4 | 2 | 347 | 6,800 | 28·15 | 19-pr.6 3-prs. | 2 | 62 | 37 |
| Casque .. .. .. .. .. | Havre(F.&C.) | 1910 | 246·4 | 25 | 10·0 | 3 | 820 | 14,400 | 34·90 | 2 25pr.,4-9pr. | 4 | 62 | 160 |
| Cavalier .. .. .. .. .. | Normand .. | 1910 | 222·0 | 21·8 | 10·5 | 3 | 527 | 8,600 | 31·19 | 4–9 prs. | 2 | 62 | 150 |
| Cimeterre .. .. .. .. .. | Bordeaux .. | 1911 | 253·4 | 28·7 | 10·0 | 2 | 894 | 13,500 | 31·15 | 2-25pr.,4-9pr. | 4 | 62 | 160 |
| Claymore .. .. .. .. .. | Normand .. | 1906 | 196·8 | 21·6 | 11·4 | 2 | 339 | 7,600 | 30·45 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Cognée .. .. .. .. .. | Toulon .. | 1907 | 197·0 | 21·6 | 11·4 | 2 | 397 | 6,800 | 27·04 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Coutelas .. .. .. .. .. | Rochefort .. | 1907 | 197·4 | 21 | 10·0 | 2 | 351 | 7,000 | 29·07 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Fanion.. .. .. .. .. .. | Bordeaux .. | 1908 | 197·0 | 21·7 | 11·5 | 2 | 360 | 6,800 | 29·06 | 1-9pr. 6-3prs. | 2 | .. | .. |
| Fanfare .. .. .. .. .. | Normand .. | 1907 | 197.0 | 21·7 | 11·5 | 2 | 361 | 6,600 | 28·0 | 1-9pr. 6-3prs. | 2 | 62 | 84 |
| Glaive.. .. .. .. .. .. | Rochefort .. | 1908 | 197·4 | 22·4 | 11·8 | 2 | 358 | 6,800 | 27·90 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Hache .. .. .. .. .. .. | Toulon .. | 1908 | 191·0 | 21·5 | 11·4 | 2 | 359 | 6,800 | 26·48 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Harpon .. .. .. .. .. | Bordeaux .. | 1902 | 216·0 | 21 | 10·6 | 2 | 314 | 6,600 | 30·7 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Hussard .. .. .. .. .. | Lorient .. | 1908 | 221·2 | 22·8 | 10·0 | 2 | 407 | 7,750 | 30·0 | 6–9 prs. | 3 | 62 | 120 |
| Lansquenet .. .. .. .. | Bordeaux .. | 1909 | 216·0 | 20·8 | 10·0 | 3 | 542 | 8,129 | 28·8 | 6–9 prs. | 3 | 62 | 150 |
| Mameluck .. .. .. .. .. | Nantes .. | 1909 | 197·2 | 22·8 | 10·0 | 2 | 407 | 7,750 | 30·5 | 6–9 prs. | 3 | 62 | 150 |
| Massue .. .. .. .. .. | Toulon .. | 1908 | 197·4 | 21·7 | 11·4 | 2 | 350 | 7,128 | 28·4 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Mortier .. .. .. .. .. | Rochefort .. | 1906 | 185 | 21·5 | 11·3 | 2 | 347 | 6,800 | 29·5 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Obusier .. .. .. .. .. | Rochefort .. | 1906 | 197 | 21·5 | 11·2 | 2 | 344 | 6,800 | 28·3 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Oriflamme.. .. .. .. .. | Nantes .. | 1908 | 184 | 21·7 | 11·6 | 2 | 366 | 7,226 | 29·5 | 1-9pr. 6-3prs. | 3 | .. | .. |
| Pierrier .. .. .. .. .. | Rochefort .. | 1907 | 186 | 21·5 | 11 | 2 | 332 | 6,800 | 27·1 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Poignard .. .. .. .. .. | Rochefort .. | 1909 | 189 | 22 | 11 | 2 | 358 | 6,800 | 28 | 1-9pr. 6-3prs. | 2 | 62 | 75 |
| Sape .. .. .. .. .. .. | Rouen .. | 1907 | 224 | 21·7 | 11·5 | 2 | 350 | 6,400 | 30 | 1-9pr. 6-3prs. | 3 | .. | .. |
| Spahi .. .. .. .. .. .. | Havre.. .. | 1908 | 207 | 21·7 | 10 | 2 | 455 | 9,000 | 29·4 | 6–9 prs. | 3 | 62 | 120 |
| Tirailleur .. .. .. .. .. | Bordeaux .. | 1908 | 197·3 | 22·8 | 9·6 | 3 | 479 | 7,800 | 27·3 | 6-9 pr. | 2 | 62 | 120 |
| Trident .. .. .. .. .. | Rochefort .. | 1907 | | 21·5 | 11 | 2 | 347 | 6,800 | 28·1 | 1-9pr. 6-3prs. | 2 | 62 | 37 |
| Com. Bory, Francis Garnier, Com. Rivière, Capt. Mehl, Dehorter (5) .. | Normand, &c. .. .. | 1912 | 253·6 | 25·4 | 10·0 | 3 | 780 | 14,100 | 31 | 2 3·9-in., 4 9 prs. | 4 | 81 | 120 |
| Bisson .. .. .. .. .. Protet, Magon, Comm. Lucas, Mangini (4) .. | Toulon, etc. | 1912 & 1913 | 272·4 | 26 | 10·0 | 3 | 800 | 15,000 | 31 | 2 3·9-in., 4 9 prs. | 2 dbl. | 81 | 120 |
| Enseigne Henry, Aspirant Herbert (2) .. .. | Rochefort .. | 1911 & 1912 | 221 | 21·6 | 10·3 | 2 | 475 | 7,500 | 28·5 | 6–9 prs. | 3 | 62 | 50 |
| Ens. Roux, M. P. Lestin, Ens. Gabolde (3) .. .. | Rochefort & Normand | 1915–1920 | 271 | 26·9 | 10·0 | 2 | 880 | 20,000 | 31 | 2 3·9-in., 4 9 prs. | 3 dbl. | 81 | .. |
| TORPILLEURS D'ESCADRE— | | | | | | | | | | | | | |
| Téméraire, Intrepide, Opiniatre, Aventurier | Nantes .. | 1911 | 270 | .. | .. | .. | 950 | 18,000 | .. | 4 3·9 in. | 4 | .. | .. |
| Annamite, Algérien, Arabe, Bambara, Hova, Kabyle, Marocain, Sakalave, Sénégalais, Somali, Tonkinois, Touareg, Marsouin .. .. .. | Japan .. .. | 1917 | 272 | 24 | 7·10 | .. | 685 | 10,000 | 29 | 1–4·7 in., 4–12 prs. | 2 dbl. | .. | .. |
| SEA-GOING— | | | | | | | | | | | | | |
| Audacieux.. .. .. .. .. | Nantes .. | 1900 | 144·2 | 15·2 | 10 | 2 | 185 | 4,200 | 26·1 | 2–3 prs. | 3 | .. | 18 |
| Borée .. .. .. .. .. .. | Bordeaux .. | 1901 | 152 | 17 | 8 | 2 | 178 | 3,900 | 29·5 | 2–3 prs. | 2 | .. | 18 |
| Bourrasque .. .. .. .. | Normand .. | 1901 | 147·7 | 16 | 8 | 2 | 160 | 4,400 | 31·4 | 2–3 prs. | 2 | .. | 18 |
| Mistral .. .. .. .. .. | Normand .. | 1901 | 153 | 17 | 8·8 | 2 | 186 | 4,018 | 28·2 | 2–3 prs. | 3 | .. | 23 |
| Rafale.. .. .. .. .. .. | Normand .. | 1901 | 147·7 | 17 | 8 | 2 | 167 | 4,400 | 31·1 | 2–3 prs. | 2 | .. | 18 |
| Simoun .. .. .. .. .. | Havre .. | 1901 | 152·7 | 17 | 9 | 2 | 186 | 4,600 | 27·7 | 2–3 prs. | 3 | .. | 18 |
| Siroco .. .. .. .. .. .. | Normand .. | 1901 | 152·7 | 17 | 9 | 2 | 186 | 4,300 | 28·7 | 2–3 prs. | 3 | .. | 23 |
| Tramontane .. .. .. .. | Bordeaux .. | 1901 | 152·7 | 17 | 9 | 2 | 162 | 3,900 | 29·8 | 2–3 prs. | 2 | .. | 18 |
| Trombe .. .. .. .. .. | Nantes .. | 1900 | 147·8 | 17 | 8·8 | 2 | 185 | 4,200 | 26 | 2–3 prs. | 3 | .. | 18 |
| Typhon .. .. .. .. .. | Havre .. | 1901 | 152·7 | 17 | 8 | 2 | 186 | 4,600 | 27·7 | 2–3 prs. | 3 | .. | 18 |

Many of the destroyers and sea-going torpedo-boats have been removed from these lists. Six destroyers and 12 torpedo-boats are in the programme.

The following ex-enemy destroyers: Rogeot de la Touche (*ex* H 146), Delage (*ex* H 147), 900 tons, 33·3 knots; Chastaing (*ex* S 133), Vesco (*ex* S 134), Mazaret (*ex* S 135), Deligny (*ex* S 139), 910 tons, 33·7 knots; also Buino, Durand, and Leblanc.

TORPEDO BOATS.—The following are the numbers of the existing torpedo boats (86-100 tons) built 1899-1906. It has been decided that many of them shall not be taken in hand for any extensive refit. All of them will soon disappear: 231, 238, 243, 250, 252, 258, 259, 274, 276, 278, 279, 280, 288, 296, 297, 299, 301, 302, 308, 310, 312, 313, 315, 316, 318, 321, 322, 327 329, 330, 332, 337, 339, 341, 347, 349-352, 357, 360-362, 365-369.

## France—*continued.*

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | |
| SUBMARINES— | | | | | | | | | | | | |
| Nivôse, Brumaire, Frimaire .. .. .. | Cherbourg .. | 1907 to 1912 | 170·8 | 18·0 | 10·3 | 2 | 398 | 700 | 9¾–12¼ | .. | 7 | 24 |
| Euler, Franklin, Faraday, Volta, Newton, Montgolfier, Arago, Curie, Le Verrier | Cherbourg .. Rochefort .. Toulon .. | 1909 1912 | 160 | 16·4 | 13·6 | 2 | 398 | 340 | 7¾–12¼ | .. | 7 | 24 |
| Clorinde, Cornélie, Amphitrite, Astrée, Artémis, Aréthuse, Atalante, Amaranthe, Andromaque .. .. | Rochefort .. | 1913 1915 | 174 | 16·9 | 10·9 | 2 | 410 | 1,300 | 15·8 | .. | 8 | 20 |
| Néréide .. .. .. .. | Cherbourg .. | 1913 | 243 | 19·8 | 14·4 | 2 | 787–1000 | 4,800 | 10–20 | .. | 8 | 40 |
| Bellone, Hermione, Gorgone .. .. .. .. | Rochefort .. Toulon .. | 1914 & 1915 | 198·9 | 17·7 | 11·9 | 2 | 520 | 1,800 | 17 | .. | 8 | 29 |
| Daphne.. .. .. .. .. | Cherbourg .. | 1915 | 228 | 18·0 | 12·0 | 2 | 633 | 1,800 | 15·1 | 1-75mm., 1 M. | 10 | .. |
| Joessel, Fulton .. .. | Cherbourg .. | 1917 | 243 | 20·0 | 13·4 | 2 | 870 | .. | 16·8 | 2-75mm., 1 M. | 10 | .. |
| Laplace .. .. .. .. | Rochefort .. | 1917 | | | | | | | | | | |
| Lagrange, Regnault .. | Toulon .. | 1917 | 247 | 21·0 | 13·0 | 2 | 840 | .. | 16·5 | ,, ,, | 10 | .. |
| Romazzotti .. .. .. .. | Toulon .. | 1918 | | | | | | | | | | |
| Amazone, Antigone .. | Schneider .. | 1918 | 184·6 | 17·0 | 10·6 | 2 | 665-467 | 2,000 | 17·5 | 1-2 pr., 1 M. | 6 | .. |
| Regnault, L. Dupetit-Thouars, Henry Fournier | Chalons .. | 1919 & 1920 | 172 | 15·6 | 9·6 | .. | 335-502 | 1020–460 | 8·14 | 1 gun .. | 4 | .. |
| Paul Chailley .. .. | Havre .. .. | 1920 | 246 | .. | .. | .. | 866–1171 | 1800–1400 | 13·5–85 | 1-12 pr., 2 M. 64 mines | 4 | .. |
| Maurice Callot .. .. | Bordeaux .. | 1920 | 246 | .. | .. | .. | 861–1211 | 2900–1600 | 17–10 | 1-12 pr., 2 M. 64 mines | 4 | .. |
| Roland Morillot (*ex*-U.B. 26) .. .. .. | | 1916 | 118·6 | 15 | 12 | .. | 250–290 | 280–240 | 8·5–6 | .. | 4 | .. |

Ten other German submarines surrendered have been embodied in the French flotilla and have received the following names: Jean Roulier, Pierre Marast, Halbroun, René Audry, Léon Mignot, Jean Autric, Victor Reveille, Jean Corre, Carissan and Trinité Schillémans. All were built in 1917–1918, and are large boats of great range (7000–1000 miles), with four or six torpedo tubes, and one or more 4-in. guns. The V. Reveille is a mine-layer (36 mines).

Fifty-three submarines have been removed from the list. Twelve submarines are in the programme of 1920.

## Greece.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Coal Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons |
| Nafkratoussa .. | Yarrow .. | 1906 | 220 | 20·6 | 7·2 | 2 | 350 | .. | 32·1 | 2 12, 4 6-pr. | 2 | 58 | 80 |
| Thyella .. .. .. | | | | | | | | | 31·79 | | | | |
| Sphendoni .. .. | | | | | | | | | 31·84 | | | | |
| Lonchi .. .. .. .. | | | | | | | | | 32·53 | | | | |
| Nike.. .. .. .. .. | Stettin (Vulcan) | 1906 | 220 | 20·6 | 7·2 | 2 | 350 | .. | 30 | 2 12, 4 6-pr. | 2 | 58 | 80 |
| Aspis .. .. .. .. | | | | | | | | | | | | | |
| Velos .. .. .. .. | | | | | | | | | | | | | |
| Aetos, Leon, Panthir, Jerax .. | Birkenhead | 1911 | 285 | 29·9 | 9·6 | .. | 980 | 19,750 | 32 | 4 4-in. | 4 | 110 | 225 |
| Keravnos .. .. .. Nea Genea .. .. | Stettin .. | 1911 | .. | .. | .. | .. | 750 | .. | 32·5 | 4 3·4-in. | 2 | .. | .. |
| SUBMARINES— | | | | | | | | | | | | | |
| Delphin, Xiphias .. | Chalon sur Saône .. | 1911–12 | 164 | .. | .. | .. | 300–460 | .. | 14·9 | .. | 5 | .. | .. |

Six 125-ton torpedo-boats built by the Vulcan Co. at Stettin: Arethusa, Doris, Aigli, Dafni, Alcyon, Thetis.

The surrendered Austrian destroyer Ulau, has been added to the Greek Navy, as also, for police duties, the torpedo-boats: F 92, 94, 95; and M 98, 99, 100.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Dimensions. Beam. | Dimensions. Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| DESTROYERS— | | | | | | | | | | | | | |
| Aquilone .. .. .. | Naples (Pattison) | 1901 | 210 | 19·4 | 7·6 | 2 | 330 | 6,000 | 30 | 4 14-pr. | 4 | 53 | 60 |
| Zeffiro .. .. ..<br>Espero .. .. .. | Naples (Pattison) | 1904 | 210 | 19·4 | 7·6 | 2 | 330 | 6,000 | 30 | 4 14-pr. | 3 | 53 | 60 |
| Bersagliere .. ..<br>Artigliere.. .. ..<br>Granatiere .. ..<br>Lanciere .. .. ..<br>Alpino .. .. ..<br>Corazziere .. ..<br>Pontiere .. .. ..<br>Carabiniere .. ..<br>Fuciliere .. .. .. | Genoa (Ansaldo) | 1906<br>1907<br>1909<br>1910 | 211·6 | 20·0 | 7·6 | 2 | 365 | 6,000 | 30 | 4 14-pdr. | 3 | 55 | 82 |
| Impavido.. .. ..<br>Indomito .. .. ..<br>Insidioso .. .. ..<br>Irriquieto.. .. .. | Naples (Pattison) | 1912 & 1913 | 246 | 24·6 | 7·6 | 2 | 650 | 15,000 | 35·2 | 5 4-in , 2 2-pr., A.A. | 2 | .. | 100 |
| Ardito .. .. ..<br>Ardente .. .. ..<br>Animoso .. .. .. | Orlando (Leghorn) | 1912 & 1913 | 246 | 24·6 | 7·6 | 2 | 650 | 15,000 | 35·5 | 5 4-in., 2 2-pr., A.A | 2 | .. | .. |
| Ascaro | Ansaldo .. | 1912 | 211·5 | 20·0 | 6·6 | 2 | 380 | 6,000 | 29 | 2 14-pr.<br>4 6-pr. | 3 | .. | 80 |
| Francesco Nullo ..<br>Antonio Mosto ..<br>Giuseppe Sirtori ..<br>Francesco Stocco ..<br>Giovanni Acerbi ..<br>Vincenzo Orsini ..<br>Giacinto Carini ..<br>Rosolino Pilo .. ..<br>Giuseppe Abba ..<br>Simone Schiaffino ..<br>Pilade Bronzetti ..<br>Giuseppe Missori ..<br>Ippolito Nievo.. .. | Naples (Pattison)<br>Genoa (Odero) | 1913 & 1914 | 238 | 24 | 8·9 | 2 | 770 | 18,000 | 33 | 6 4-in., 2 2-pr., 2 M. Carry also 10 mines | 2 dbl. | 100 | 170 |
| Giuseppe La Masa..<br>Angelo Bassini ..<br>Nicola Fabrizii ..<br>Giacomo Medici ..<br>Agostino Bertani ..<br>Giuseppe la Farina | Genoa (Odero) | 1917 & 1918 | 238 | 24 | 9·0 | 2 | 770 | 18,000 | 33 | 4 4-in., 2 14-pr., 2 M. Carry also 10 mines | 2 dbl. | 100 | 170 |
| Audace .. .. .. | Yarrow .. | 1918 | 275 | 27·6 | 8·3 | 2 | 922 | 21,500 | 36 | 1 4-in.<br>6 3-in. | 2 dbl. | 111 | 252 |
| Ardimentoso, ex-S. 63 .. .. .. .. | | 1915 | 274 | 27·3 | 8·6 | 2 | 908 | 25,000 | 31·5 | 3 4·1-in. | 6 | .. | 305 |
| FIRST CLASS— | | | | | | | | | | | | | |
| Sirio, Sagittario ..<br>Spica .. .. ..<br>Alcione, Ardea ..<br>Albatros, Aiorone ..<br>Astore, Arpia .. .. | Elbing ..<br>Odero .. .. | 1905–6<br>1905<br>1906 | 164 | 19·6 | 6·3 | 2 | 215 | 2,900<br>3,250 | 25 | 2 14-pr., A.A. | 2 | .. | 40 |
| Pegaso .. .. ..<br>Procione .. .. ..<br>Pallade .. .. ..<br>Cigno .. .. ..<br>Cassiopea .. ..<br>Calliope .. .. ..<br>Clio .. .. ..<br>Centauro .. .. ..<br>Canopo .. .. ..<br>Calipso .. .. ..<br>Climene .. .. .. | Naples (Pattison)<br>Naples (Pattison)<br>Naples (Pattison) | 1905<br>1905<br>1906<br>1907<br>1906<br>1907<br>1907<br>1909<br>1909 | 164 | 17·4 | 7·0 | 2 | 200 | 3,000 | 25·4<br>26·6 | 2 14-pr., A.A. | 3 | | 40 |
| 1 P.N.–12 P.N.* ..<br>13 O.S.–24 O.S. ..<br>25 A.S.–32 A.S. ..<br>33 P.N.–38 P.N. ..<br>39 R.M. .. .. .. | Pattison ..<br>Odero .. ..<br>Ansaldo ..<br>Pattison ..<br>Spezia.. .. | 1912 & 1913<br>1914 | 139 | 13·9 | 5·5 | 2 | 130 | 2,500 | 27 | 1 6-pr. | 2 | .. | 15 |
| Additional boats of this class 40–45, 64–69 P.N. (Pattison); 46–51 O.S. (Odero); 52–57 A.S. (Ansaldo), 58–63, 74–75 O.L. (Orlando). | Pattison ..<br>Odero.. ..<br>Orlando ..<br>Ansaldo .. | 1916<br>1920 | 139 | 13·5 | 5·5 | 2 | 157 | 3,000 | 27–29 | 2 12-pr. | 2 | .. | 25 |
| F. Rismondo, ex Austrian T.B. 11 | | 1910 | 142 | 14 | .. | 2 | 110 | 2,400 | 28 | 2 3-pr. | 2 | .. | .. |

**Launched and under construction are the following destroyers: Palestro, Solferino, San Martino, Confienza, 900 tons Curtatone, Castelfidardo, Calatafimi, Monzambano, 930 tons (Orlando, Leghorn), 270 feet long, 26 feet beam, 12 feet draught 15,500 h.p., 32 knots, four 4-in. guns and two 12-pr. A.A., four T.T. Four others are in the programme. Six, unnamed, of the La Masa class, 800 tons, are being built by Odero, Leghorn.**

**Seven *ex* Austrian destroyers have been added, as follows: Cortellazzo (*ex* Lika), Fasana (*ex* Tatra), Grado (*ex* Triglav), Monfalcone (*ex* Uszok), Muggia (*ex* Csepel), Pola (*ex* Orgen), Zenzon (*ex* Balaton), built at the Danubius yard, Fiume, 1912–1916, 850 tons, 250 feet long, 25 feet beam, 8 feet 3 in. draught, 20,600 h.p., 32·5 to 33 knots, two 3·9 in. and two 9-pr., six T.T. The Lika and Triglav were built to replace two of the same name lost during the war.**

*** P.N. 5, 17, and 36, and O.S. 7 have been lost from these series.**

## Italy—*continued.*

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| SUBMARINES— | | | | | | | | | | | | | |
| L. Galvani, E. Torricelli, P. Micca .. | Spezia .. .. | 1917<br>1919 | 207·5<br>218·0 | 20·3<br>19·0 | 15·6<br>15·6 | ..<br>.. | 830/1000<br>740/920 | 2600 | 15 9·5<br>17–9·2 | 2 14-pr. A.A. | 6 | .. | .. |
| L. Mocenigo .. ..<br>L. Marcello .. ..<br>A. Emo .. .. .. | Venice.. .. | | | | | | | | | | | | |
| A. Barbarigo .. ..<br>A. Provana .. ..<br>S. Veniero .. ..<br>G. Nani .. .. .. | Spezia, F.I.A.T. | | | | | | | | | | | | |
| X 2, 3 .. .. .. | Ansaldo .. | 1917 | 139·9 | 18 | 11 | .. | 400/460 | 660/320 | 9·2–6·3 | 1 12-pr.<br>18 mines | .. | .. | .. |
| H 1 to 4, 6 to 8 .. | Vickers .. | 1917 | 15·0 | 16 | 12 | .. | 360/440 | 960<br>980 | 12–8·9 | 1 12-pr. | 4 | 22 | .. |
| F 1, 2, 5, 6, 7, 9, 10, 12–21 .. .. .. | F.I.A.T. ..<br>Odero .. ..<br>Orlando .. | 1917<br>1918 | 148 | 14 | 10 | .. | 260/380 | 700<br>320 | 13–8·5 | 1 12-pr. A.A. | 2 | .. | 12 |
| N 1 to N 6 .. .. | .. | 1917<br>1918 | 150 | 14 | 9-9 | .. | 270/350 | 700<br>250 | 13·6-8 | 1 12-pr. A.A. | 2 | .. | .. |
| F. *ex* Argonauta .. | Ansaldo .. | 1913 | 148·3 | 13·9 | 9-1 | .. | 250/300 | 700/250 | 13-9 | 1 12-pr. A.A. | 2 | .. | .. |

Four submarines, 600 tons submerged, are in the new programme.

## Japan.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| DESTROYERS— | | | | | | | | | | | | | |
| Shirakumo, Asashio | Thornycroft | 1901–2 | 216·7 | 20·7 | 6·0 | 2 | 373 | 7,400 | 31 | 1 12-pr.,<br>5 6-prs. | 2 | 59 | 96 |
| Akebono, Oboro .. | Yarrow .. | 1899–1902 | 220·0 | 20·6 | 5·2 | 2 | 311 | 6,000 | 31 | 1 12-pr.,<br>5 6-prs. | 2 | 55 | 95 |
| Asagiri, Murasame | Yokosuka .. | 1902 | 220·3 | 20·6 | 6·0 | 2 | 374 | 6,000 | 29 | 2 12-pr.,<br>4 6-prs. | 2 | .. | .. |
| Hatsushima, Yayoi, Kisaragi, Hibiki, Wakaba, Hatsuyuki, Kamikaze, Ariake | Yokosuka .. | 1905–6 | 220·3 | 20·6 | 6·0 | 2 | 374 | 6,000 | 29 | 6 12-pr. | 2 | .. | .. |
| Fubuki, Arare ..<br>Yunagi, Oite .. ..<br>Asakase, Harukase<br>Shigure, Hatsuharu<br>Yuguri, Yudachi ..<br>Mikadzuki, Nowake<br>Uschio, Nenohi ..<br>Shiratsuyu, Hayate | Yokosuka ..<br>Maizuru ..<br>Kobe .. ..<br>Sasebo.. ..<br>Kure .. ..<br>Nagasaki .. | 1905–6 | 220·3 | 20·6 | 6·0 | 2 | 374 | 6,000 | 29 | 6 12-pr. | 2 | .. | .. |
| Shirayuki, Matsukase<br>Asatsuyu, Hayakase<br>Kikutsuki, Minatsuki<br>Nagatsuki, Utsuki..<br>Isonami, Uranami..<br>Ayanami .. .. .. | Nagasaki ..<br>Osaka .. ..<br>Uraga .. ..<br>Yokosuka .. | 1906–10 | 220·3 | 20·6 | 6·0 | 2 | 374 | 6,000 | 29 | 6 12-prs. | 2 | 70 | 90 |

## Japan—*continued.*

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Dimensions. Beam. | Dimensions. Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS—*contd.* | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Sakura, Tashibana .. | Kure .. .. | 1912 | 288·0 | .. | 7·3 | 3 | 600 | 18,000 | 30 | 1 4·7-in.<br>4 12-pr. | 4 | .. | .. |
| Kaba .. .. .. ..<br>Kaede .. .. .. ..<br>Kashiwa .. .. .. ..<br>Katsura .. .. .. ..<br>Kiri .. .. .. .. ..<br>Kusunoki .. ..<br>Matsu .. .. ..<br>Sakaki .. .. ..<br>Sugi .. .. .. ..<br>Ume .. .. .. .. .. | Yokosuka ..<br>Maizuru ..<br>Nagasaki ..<br>Kure .. ..<br>Uraga .. ..<br>Kawasaki ..<br>—<br>Sasebo .. ..<br>Osaka .. ..<br>Kawasaki .. | 1915 | 260·0 | 24 0 | 7 9 | 3 | 665 | 9,500 | 30 | 1 4·7 in.<br>4 12-pr. | | .. | .. |
| Momo, Yanagi ..<br>Kashi, Hinoki .. | Sasebo .. ..<br>Maizuru .. | 1916-17 | 275·0 | 25·0 | 7·9 | .. | 835 | 16,000 | 31·5 | 3 4·7 in.,<br>2 M. | 6 | .. | .. |
| Nara .. .. .. ..<br>Kuwa, Tsubaki ..<br>Maki, Keyaki .. ..<br>Yenoki .. .. ..<br>Momi, Take .. ..<br>Nashi, Kaki .. ..<br>Kaya, Kure .. ..<br>Nire, Tsuga .. .. | Yokosuka ..<br>Kure .. ..<br>Sasebo .. ..<br>Maizuru ..<br>Maizuru, etc. | 1917-18 | 275·0 | 25·0 | 7·9 | .. | 835 | 16,000 | 31·5 | 3 4·7 in.,<br>2 M. | 6 | .. | .. |
| Umikaze, Yamakase | Maizuru .. | 1909-11 | 310·0 | .. | 9·0 | .. | 1200 | 20,500 | 33 | 2 4·7-in.,<br>5 12-pr. | 4 | 123 | .. |
| Urakaze .. .. .. | Yarrow .. | 1915 | 275·3 | 27·6 | 7·11½ | 2 | 955 | 22,000 | 28 | 1 4·7-in.,<br>4 12 pr. | 4 | .. | .. |
| Amatsukaze .. ..<br>Tokitsukaze .. ..<br>Isokaze .. .. ..<br>Hamakaze .. .. | Kure .. ..<br>Kawasaki ..<br>Kure .. ..<br>Nagasaki .. | 1916 | 310·0 | 28·0 | 9·3 | .. | 1227 | 27,000 | 34 | 4 4·7-in. | 6 | .. | .. |
| Tanikase, Minekase<br>Kawakase .. ..<br>Sawakase .. .. ..<br>Okikase, Shimakase,<br>Nadakase, Yakase,<br>Hakase | Maizuru ..<br>Yokosuka ..<br>Mitzubishi ..<br>Maizuru .. | 1916–19 | 320 | 29 | 9·5 | .. | 1300<br>1350 | 28,000 | 34 | 4 4·7-in.,<br>2 M. | 6 | .. | .. |
| Suzukase, Soyokase,<br>Sumujikase,<br>Makase, Okase,<br>Namikase,<br>Numakase, Nokase,<br>Tashikase, Shiokase,<br>Hokase, Yukase,<br>Akikase | Kawasaki, Yokosuka, etc. | 1921 and Bldg. | 320 | 29 | 9 5 | .. | 1345 | 38,500 | 36 | 4 5·5-in.<br>or<br>5 4·7-in. | 6 | .. | .. |

To be completed by 1922, twenty-five second-class destroyers, 900 tons, 33 knots, 4 or 6 T.T.: Susuki, A-oi, Kiku, Fuji, Yanogi, Warabi, Tade, Tsuta, Hishi, Sumure, Ashi, Hasu, Shion, Nadeshiko, Botan, Ajesai, Yuri, Ayami, Omodaka, Karukayo, Kikyo, Tsutsuji, Basho, Kaido, Kakitsubata. About twenty others of the same class are planned, as also sixteen of the powerful "Kase" class, reported to displace 1900 tons and to mount 4·7-in. guns, with 3, 4, or 6 T.T.

SUBMARINES.—The oldest Japanese submarines date from 1901–5, when five were purchased from the Fore River Company, U.S.A. The Japanese began to build in the following year, and two boats were supplied by Vickers in 1908. Thirteen boats had been completed before the war, and the Kawasaki Company added two in 1919, provided with four T.T. All these are small vessels, designed for local employment. Their highest surface speed is 14 knots. One sea-going submarine dates from 1914, and has surface displacement of 670 tons and 17 knots speed, with six T.T. and range of 2200 miles. Ten others have since been completed, the displacement rising to 1000 tons and the range to over 7000 miles. Each of these mounts a small gun, and has four or five T.T. The later boats are of Laurenti type, and have been built by the Kawasaki Company. It is expected to complete about thirty additional boats in 1921–23. The surface displacement is increased to about 1250 tons or more, and the range extended to 11,000 miles. It is stated that the surface speed is 17 knots, that some of the boats carry a 5·5-in. gun, and have from four to six T.T., and that some are fitted as mine-layers. The Japanese sea-going submarine flotilla should thus comprise over forty boats. About thirty others are building and projected, including several of the cruiser type.

## Netherlands.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Dimensions. Beam. | Dimensions. Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Wolf, Fret (1909) .. Bulhond, Jakhals (1910) Hermelijn, Lynx, Panter, Vos (1911) | Flushing .. | 1910–1913 | 230 | 20·6 | 9 | 2 | 480 | 7,500 | 30 | 4 12-pr., 4 M. | 2 | 84 | 80 |
| FIRST CLASS— | | | | | | | | | | | | | |
| Minotaurus, Python | Flushing .. | 1904 | 152·6 | 15·3 | 7·9 | 1 | 130 | 1,900 | 27 | 2 3-prs. | 2 | 25 | 36 |
| Zeeslang, Krokodil, Draak, Sfinx, Scylla | Flushing .. | 1905 | 152·6 | 15·3 | 7·9 | 1 | 130 | 1,900 | 27 | 2 3-prs. | 2 | 25 | 36 |
| G 13-15-16 .. .. | Scheldt .. Fijenoord .. | 1914 | 165 | 17·3 | 9·5 | .. | 188 | 2,000 | 26 | 2 12-pr. | 3dbl | .. | .. |
| Z 1–4.. .. .. .. | Amsterdam | 1916–1917 | 201 | 20·4 | 6 | 2 | 322 | 5,500 | 27 | 2 12-pr., 2 M. | 2 1dbl | 39 | 53 |
| Z 5–8.. .. .. .. | Scheldt .. Fijenoord .. | 1915 | 192 | 30 | 5, 6 | 2 | 310 / 322 | 5,500 / 5,700 | 27 / 27 | 2 12-pr., 2 M. | 2 1dbl | 39 | 81 |

The named destroyers and first-class boats belong to the forces of the Dutch Indies. Additions are planned. There is a small flotilla of torpedo-boats.

SUBMARINE boats.—O 1 (*ex*-Luctor et Emergo), O 2 and 3, 132–150 tons, 11·8 knots, 2 tubes. O 4 and 5, 380 tons, 151 ft. 6 in. long, 16 knots (surface), 11 knots (submerged) speed. O 6 and 7, built in Holland, 178–234 tons. British interned submarine bought by the Dutch Government and taken over as O 8, June, 1917. K 1 for the East Indies, 320–390 tons, 105 ft. long, 10 ft. beam, 300 h.p. (Diesel), and 300 h.p. (electric), 16 knots (surface), 11 knots (submerged speed), 2 tubes; K 2 and K 3, of the same class, built for the Dutch Indies. Seven large K submarines built at the Fijenoord dockyard and Scheldt (1918 and building). All the K boats are intended for the Dutch Indies. Submarine mine-layer M 1 (*ex*-German).

## Norway.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Dimensions. Beam. | Dimensions. Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESTROYERS— | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| Valkyrien .. .. | Elbing .. | 1896 | 190 | 24·3 | 9·3 | 2 | 380 | 3,300 | 23·2 | 4 12-pdrs. | 2 | 59 | 90 |
| Draug, Troll, Garm | Horten .. | 1908–13 | 226 | 25·0 | .. | 2 | 540 | 7,500 | 27·0 | 6 12-pdrs. | 3 | 71 | 95 |
| FIRST CLASS— | | | | | | | | | | | | | |
| Snoegg, Stegg, Trygg | Horten .. | 1919–1920 | 175 | 18 | 5½ | 2 | 220 | 3,500 | 25 | 2 12-pdr. | 4 | 31 | 29 |
| SECOND CLASS— | | | | | | | | | | | | | |
| Hval, Delfin .. .. | Elbing .. | 1896–1900 | 130·0 | 15·0 | 6·9 | 1 | 84 | 1,100 | 24·5 | 2 1·4-in. Q.F. | 2 | 19 | 17 |
| Storm, Brand, Trods | Horten .. | | 128·0 | 15·0 | .. | 1 | 84 | 1,100 | 23 | 2 1·4-in. Q.F. | 2 | 19 | 17 |
| Laks, Sild, Sael, Skrei | Horten .. | 1901 | 128·0 | 15·0 | 6·9 | 1 | 84 | 1,100 | 23 | 2 1·4-in. | 2 | 19 | 17 |
| Kjek, Hvas, Dristig Kvik, Djerv, Blink, | Fredrikstad | 1898 | 111·5 | 14·5 | 6·3 | 1 | 65 | 650 | 19 | 2 1·4-in. | 2 | .. | .. |
| Lyn, Hauk, Falk, Klimt .. .. .. | Horten .. | 1903 | | | | | | | | | | | |
| Skarv, Teist, Lom, Jo, Grib .. .. | Horten .. | 1906–7 | 134·5 | 14·9 | .. | 1 | 100 | 1,700 | 25·0 | 2 3-pr. | 2-3 | 18 | 16 |
| Ravn, Orn .. .. | Horten .. | 1903 | 119 | 14·9 | 6·4 | 1 | 73 | 1,035 | 22·5 | 2 1·4-in. | 2 | 16 | 15 |
| Kjeld.. .. .. .. | Horten .. | 1912 | 135 | 14·9 | 6·4 | 1 | 100 | 1,800 | 25 | 1 12-pr. | 3 | 19 | 16 |
| SUBMARINES— | | | | | | | | | | | | | |
| A 1, 2, 3, 4 .. .. | Germania Kiel | 1909 to 1913 | 131·6 | 14·9 | 9·6 | 2 | 220 / 255 | 440 / 250 | 12 / 9 | .. | 3 | 17 | .. |
| MINING VESSELS:— | | | | | | | | | | | | | |
| Froeya .. .. .. | Horten .. | 1917– | 250 | 27 | 8½ | 2 | 755 | .. | 22 | 4 4-in. | 2 | 80 | 95 |
| Glommen, Laugen.. | Christiania.. | 1918 | 138 | 28 | 6½ | 2 | 335 | .. | 9 5 | 2 12-pdr. | .. | 39 | 21 |

## Spain.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| DESTROYERS— | | | | | | | | | | | | | |
| Terror, Audaz.. .. | Clydebank .. | 1896 | 220 | 22 | 5·6 | 2 | 300 | 6,000 | 28 | {2 12-pr. 2<br>6-pr. 2 1-pr.} | 2 | 67 | 100 |
| Osado, Proserpina .. | Clydebank .. | 1897 | 225 | 25·6 | 5·8 | 2 | 400 | 7,500 | 30 | {2 14-pr. 2<br>6-pr. 2 1-pr.} | 2 | 70 | 90 |
| Bustamente .. ..<br>Villamil .. .. ..<br>Cadarso .. .. .. | Cartagena ..<br>Cartagena ..<br>Cartagena .. | 1915 | 220 | 22 | 7·5 | .. | 370 | 6,250 | 28 | 5 6-pr. | 2 | .. | .. |
| FIRST CLASS— | | | | | | | | | | | | | |
| 24 boats .. .. .. | Cartagena .. | {1915 & Pro.} | 164 | 17·2 | 4·9 | 3 | 183 | 3,750 | 26 | 3 3-pr. | 3 | .. | .. |
| Azor, Halcón .. .. | Poplar.. .. | 1887 | 134·5 | 14 | 6 | 1 | 108 | 1,600 | 24 | 4 3-pr. | 3 | 23 | 25 |

Three destroyers are in hand at Cartagena: 1140 tons, 34 knots, turbines, 33,000 h.p., three 4-in., two 12-prs., 4 tubes. Three others are in the programme. Torpedo boat No. 21 has been completed at Cartagena, where No. 22 is in hand.

Azor and Halcón re-boilered by Yarrow (water-tube).

In September, 1917, three submarines (A 1, 2 and 3), built in Italy, were delivered (260-383 tons, 700–500 h.p., 13-8·5 knots, two tubes), and six others building (one launched June 2), 610-740 tons, 17-10·5 knots, two 12-pr., 6 T.T., will give Spain a flotilla of ten boats, the tenth being the Peral (500-685 tons, 17-10·5 knots, one 12-pr., 4 tubes).

## Sweden.

| Name or Number. | Where Built. | Launched. | Dimensions. Length. | Beam. | Draught. | Number of Screws. | Displacement. | Indicated Horse-Power. | Maximum Trial Speed. | Armament. | Torpedo Tubes. | Complement. | Fuel Capacity. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Feet. | Feet. | Feet. | | Tons. | | Knots. | | | | Tons. |
| DESTROYERS— | | | | | | | | | | | | | |
| Mode .. .. .. .. | Yarrow .. | 1902 | 220·3 | 20·6 | 8·9 | 2 | 480 | 6,800 | 32·4 | {1 12-pr.<br>5 6-prs.} | 2 | 55 | 95 |
| Magne .. .. .. | Thornycroft | 1905 | | | | | | | | | | | |
| Wale.. .. .. .. | Malmo .. | 1906 | | | | | | | | | | | |
| Ragnar .. .. .. | Malmo .. | 1909 | | | | | | | | | | | |
| Sigurd .. .. .. | Gothenburg | 1909 | 216·9 | 20·8 | 8·2 | 2 | 480 | 7,200 | 30·0 | {2 12-prs.<br>4 6-prs.} | 2 dbl. | 63 | 90 |
| Vidar .. .. .. | Malmo .. | 1909 | | | | | | | | | | | |
| Hugin .. .. .. | Gothenburg | 1909 | | | | | | | | | | | |
| Munin .. .. .. | Malmo .. | 1910 | | | | | | | | | | | |
| Wrangel .. .. ..<br>Wachtmeister.. .. | Gothenborg | 1918 | 230 | 22 | 8·2 | 2 | 500 | .. | 30·0 | {2 12-prs.,<br>6 4-prs.} | 2 dbl. | .. | .. |
| FIRST CLASS— | | | | | | | | | | | | | |
| Blixt.. .. .. .. | Carlskrona.. | 1898 | 128 | 15·9 | 6·11 | 1 | 92 | 1,260 | 23·5 | 2 1·9-in. Q.F. | 2 | 18 | 17 |
| Meteor .. .. .. | Carlskrona.. | 1899 | 128 | 15·9 | 6·11 | 1 | 92 | 1,330 | 23·8 | 2 1·9-in. Q.F. | 2 | 18 | 17 |
| Stjerna .. .. .. | Carlskrona.. | 1899 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·4 | 2 1·9-in. Q.F. | 2 | 18 | 17 |
| Orkan .. .. .. | Carlskrona.. | 1900 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Vind .. .. .. .. | Carlskrona.. | 1900 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Bris .. .. .. .. | Carlskrona.. | 1900 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Virgo .. .. .. | Carlskrona.. | 1902 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Mira .. .. .. .. | Carlskrona.. | 1902 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Orion .. .. ..<br>Sirius .. .. ..<br>Kapella .. .. .. | Carlskrona.. | 1903 | 128 | 15·9 | 6·11 | 1 | 92 | 1,250 | 23·5 | 2 1·5-in. Q.F. | 2 | 18 | 17 |
| Pleiad, Castor, Pollux | Normand .. | 1909 | 125 | 15 | 6·6 | 1 | 96 | 1,900 | 26 | 2 1·5-in. Q.F. | 2 | 18 | 20 |
| Vega .. .. .. ..<br>Vesta .. .. .. | Carlskrona.. | 1910 | 125 | 17·5 | 8·6 | 1 | 105 | 1,900 | 25 | {1 6-pr.<br>1 1·4-in.} | 2 | 18 | 20 |
| Spica, Astrea, Iris, Thetis .. .. .. | {Bergsund and Gothenburg} | 1910 | 125 | 17·5 | 8·6 | 1 | 105 | 1,900 | 25 | {1 6-pr.<br>1 1·4-in.} | 2 | 18 | 20 |
| Altair .. .. ..<br>Antares .. .. ..<br>Argo .. .. ..<br>Arcturus .. .. .. | Stockholm .. | 1908 | 128 | 17·5 | 8·6 | .. | 110 | 2,000 | 25 | 2 6-prs. | 2 | 18 | 20 |
| Perseus, Polaris ..<br>Regulus, Rigel ..<br>A, B, C, D .. .. | Bergsund ..<br>Stockholm ..<br>{Carlskrona & Gothenburg} | {1910–1915} | 128 | 17·5 | 8·6 | 1 | 110 | 2,000 | 25 | 12 6-pr. | 2 | 18 | 20 |
| SUBMARINES— | | | | | | | | | | | | | |
| Enroth .. .. .. | Stockholm .. | 1902 | 82·0 | 13·0 | 11·6 | 2 | 146 | 100 | 12–11 | .. | 1 | .. | .. |
| Hajen .. .. .. | Stockholm .. | 1903 | 65·0 | 11·6 | .. | .. | 120 | 200 | 10–7 | .. | .. | .. | .. |
| No. 1.. .. .. .. | Muggiano .. | 1908 | 139·6 | 14·2 | 6·9 | .. | 185–235 | 750 | 15–7½ | .. | 2 | 15 | .. |
| Nos. 2, 3, 4 .. .. | Stockholm .. | 1911 | 136·6 | 14·2 | 6·9 | .. | 185-535 | 750 | 15–7½ | .. | 2 | 15 | .. |
| Svaerdfisken .. ..<br>Tumlaren .. .. | Malmö .. | 1914 | .. | .. | .. | .. | 250 370 | .. | 15·9 | .. | 2 | .. | .. |

Also ten small torpedo-boats, 60 tons, built 1907–1908.

Later submarines: Delfinen (1915), 250–370 tons, 15–9 knots, one machine-gun, two T.T.; Aborren, Gaeddan (1915), 200 tons, (?); Bavfar, Hvalen, Hvalrossen, Iller, Otter, Saelen (1916–18), 250–370 tons. Details of the Swedish submarines are given under reserve. The above list is believed to be correct, but the facts are confidential. The new programme (1922–24) includes additional submarines.

## United States

The Destroyers of the United States Navy are now classified, like the big ships, as of the first or second line. There are now 285 of the former and 21 of the latter. The following are the second line boats, and have a maximum speed of 30 knots:—

Paulding, Drayton, Roe, Terry, Perkins, Sterett, McCall, Burrows, Warrington, Mayrant, Monaghan, Trippe, Walke, Ammen, Patterson, Fanning, Jarvis, Henley, Beale, Jouett, Jenkins (21 boats).

These boats are 289 ft. long, with 26-ft. beam, 8-ft. 4-in. draught, 742 to 900 tons displacement, 11,000 to 12,000 H.P., speed 20 to 30 knots, five 3-in. guns, three 18-in. twin torpedo-tubes, fuel 210 tons, complement 89; built 1910–11.

The first line destroyers in the succeeding lists date from 1913 onward, and mark the approach to better sea-keeping qualities, and the introduction of a bigger gun and more powerful torpedo armament. Their displacements rise from 1020 to 1215 tons, their engine-power from 15,300 to 27,000, and their speed from 30 to 35 knots.

The first named of the 35-knot boats is the **Ringgold**. All these destroyers mount four 4-in. guns, and the later boats have each two 1-pr. A.A. guns.

With the **Hart** the calibre of these last guns is increased to 3 in., but the latest boats, from the **Clemson** onward, carry only one A.A. gun.

With regard to torpedo armament the first eight boats in the following list, **Cassin** to **Balch**, have each three 18-in. twin tubes, but in most of the others the diameter is increased to 21 in., and in the boats built from the **Sampson** onward, that is, after the fortieth boat, a system of triple tubes has been installed. All these boats are from 300 ft. to 310 ft. long, with beam of 30 ft. 4 in. to 31 ft., and mean draught of about 9 ft. 4 in. They have a maximum fuel capacity of 300 tons, and complement of 98 The series is as follows:—

Cassin, Cummings, Downes, Duncan, Aylwin, Parker, Benham, Balch, O'Brien, Nicholson, Winslow, McDougal, Cushing, Ericsson, Tucker, Conyngham, Porter, Wadsworth, Wainwright, Sampson, Rowan, Davis, Allen, Wilkes, Shaw, Caldwell, Craven, Gwin, Conner, Stockton, Manley, Wickes, Philip, Woolsey, Evans, Little, Kimberley, Sigourney, Gregory, Stringham, Dyer, Colhoun, Stevens, McKee, Robinson (45 boats), 1916–18.

Ringgold, McKean, Harding, Gridley, Fairfax, Taylor, Bell, Stribling, Murray, Israel, Luce, Maury, Lansdale, Mahan, Schley, Champlin, Mugford, Chew, Hazelwood, Williams, Crane (21 boats), 1918–19. Seven of these are mine-layers.

Hart, Ingraham, Ludlow, Rathburne, Talbot, Waters, Dent, Dorsey, Lea, Lamberton, Radford, Montgomery, Breese, Gamble, Ramsay, Tattnall, Badger, Twiggs, Babbitt, De Long, Jacob Jones, Buchanan, Aaron Ward, Hale, Crowninshield, Tillman, Boggs, Kilty, Kennison, Ward, Claxton, Hamilton, Tarbell, Yarnall, Upshur, Greer, Elliot, Roper, Breckinridge, Barney, Blakeley, Biddle, Du Pont, Bernadou, Ellis, Cole, J. Fred Talbot, Dickerson, Leary, Schenck, Herbert, Palmer, Thatcher, Walker, Crosby, Meredith, Bush, Cowell, Maddox, Foote, Kalk, Burns, Anthony, Sproston, Rizal, Mackenzie, Renshaw, O'Bannon, Hogan, Howard, Stansbury, Hopewell, Thomas, Haraden, Abbot, Bagley (76 boats), 1919–20. Nine of these are mine-layers.

The following are all new 35-knot boats, many of them still uncompleted: Clemson, Dahlgren, Goldsborough, Semmes Satterlee, Mason, Graham, Abel P. Upshur, Hunt, Welborn C. Wood, George E. Badger, Branch, Herndon, Dallas, Chandler, Southard, Hovey, Long, Broome, Alden, Smith Thompson, Barker, Tracy, Borie, John D. Edwards, Whipple, Parrott, Stewart, Hatfield, Brooks, Gilmer, Fox, Kane, Humphreys, McFarland, James K. Paulding, Overton, Sturtevant, Childs, King, Sands, Williamson, Reuben James, Belknap, McCook, McCalla, Rodgers, Ingram, Bancroft, Welles, Aulick, Turner, Gillis, Delphy, McDermut, Laub, McLanahan, Edwards, Greene, Ballard, Shubrick, Bailey, Thornton, Morris, Tingey, Swasey, Meade, Sinclair, McCawley, Moody, Henshaw, Meyer, Doyen, Sharkey, Toucey, Breck, Isherwood, Case, Lardner, Putnam, Worden, Flusser, Dale, Reid, Chauncey, Fuller, Percival, John Francis Burnes, Farragut, Somers, Stoddert, Reno, Farquhar, Thompson, Kennedy, Paul Hamilton, William Jones, Woodbury, S. P. Lee, Nicholas, Young, Zeilin, Yarborough, La Vallette, Sloat, Wood, Shirk, Kidder, Selfridge, Marcus, Mervine, Chase, Robert Smith, Mullany, Preston, Lamson, Litchfield, Zane, Wasmuth, Trever, Hulbert, Noa, William B. Preston, Preble, Tillman, Pillsbury, Ford, Truxton, Paul Jones, King, Williamson, Bainbridge, Goff, Barry, Hopkins, Lawrence, Coghlan, Hull, McDonogh, Fahrenholt, Sumner, Perry, Decatur (143 boats).

### Submarines.

The submarine flotillas are as follows:—

| | | | |
|---|---|---|---|
| B 1, 2. | 1909. | 170 tons, 10–8½ knots | 2 |
| D 1, 2, 3. | 1909. | 278–340 tons | 3 |
| | | (The above are suitable only for harbour defence.) | |
| E 1, 2. | 1913–14. | 662–867 tons, 15–10 knots | 2 |
| F 2, 3. | 1914–15. | 325–400 tons, 14–9½ knots | 2 |
| G 1, 3, 4. | 1914–15. | 695–965 tons, 15½–9½ knots | 3 |
| H 1 to 9. | 1914–15. | 440–515 tons, 12–10½ knots | 9 |
| K 1 to 8. | 1916. | 1880–2650 tons, 24–9½ knots | 8 |
| L 1 to 11. | 1916–17. | 890–1080 tons, 17½–13½ knots, 4 T.T. | 11 |
| M 1. | 1918. | 740 tons, 14–11 knots | 1 |
| N 1 to 7. | 1918–19 | 331–385 tons 4 T.T. | 7 |

The following are the first line boats:—

| | | | |
|---|---|---|---|
| O 1 to 16. | 1918–19 | 584–650 tons, 4 T.T., 1 3-in., 14–10½ knots | 16 |
| R 1 to 27. | 1918–19. | 569–680 tons, 13½–10½ knots, 4 T.T. (coastal) | 27 |
| S 1 to 51. | 854–1094 tons. | All these are new boats, many of them not yet laid down, and not many of them completed | 51 |
| Fleet submarines. | 1106–1487 tons, 8 T.T., 2 1-in., 2 13-pr. | (3 T class completed, 3 V class building, six not yet contracted for.) | 12 |

The list makes a total of 154 boats, but probably not many more than 100 have been completed.

PLANS

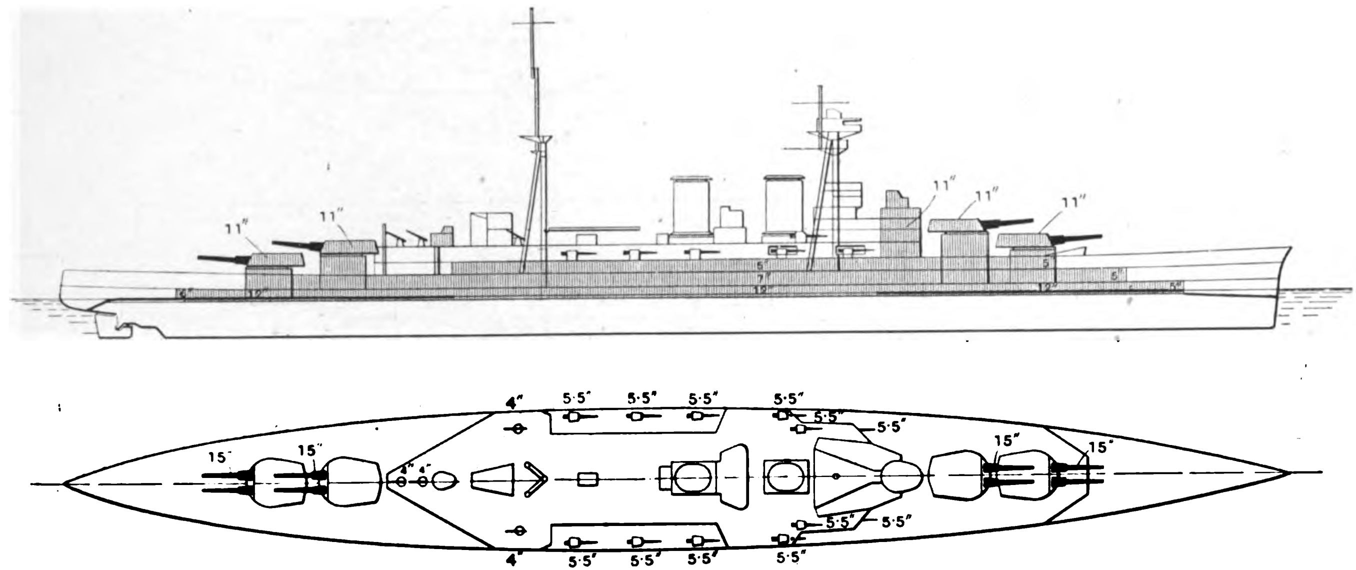
OF

BRITISH AND FOREIGN SHIPS.

## GREAT BRITAIN.

### BATTLESHIP.

### Hood.




**Length, 810 ft.; 41,200 tons; Speed, 31 knots; Completed, 1920**
**Armament, 8—15 in., 12—5·5 in., 4—4 in. H.A., 4—3 pdr.**

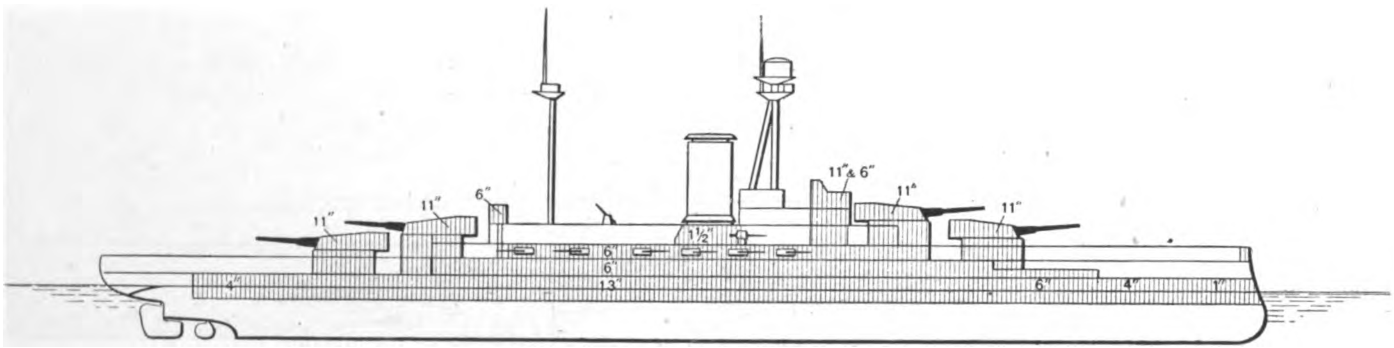


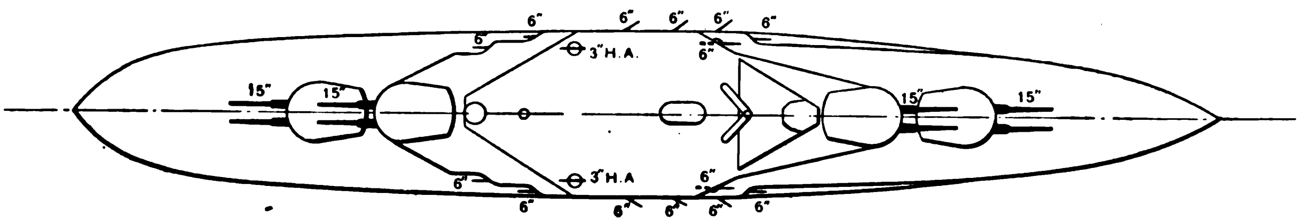
**PLATE 1.**

# GREAT BRITAIN.

## BATTLESHIPS.

**Royal Sovereign. Royal Oak. Revenge. Resolution. Ramillies.**



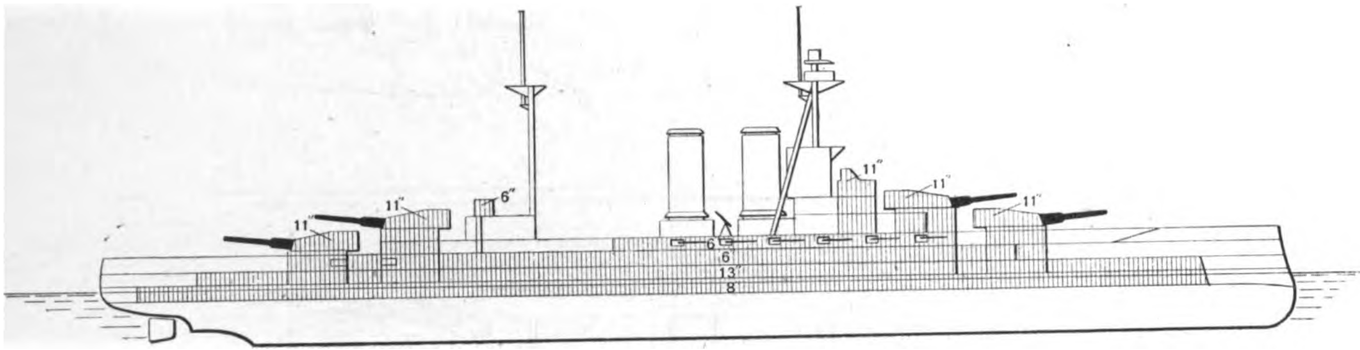

Length, 580 ft. ; 25,750 tons ; Speed, 23 knots ; Completed 1916–7 ;
Armament, 8—15 in., 14—6 in., 2—3 in. H.A., 4—3 pr.

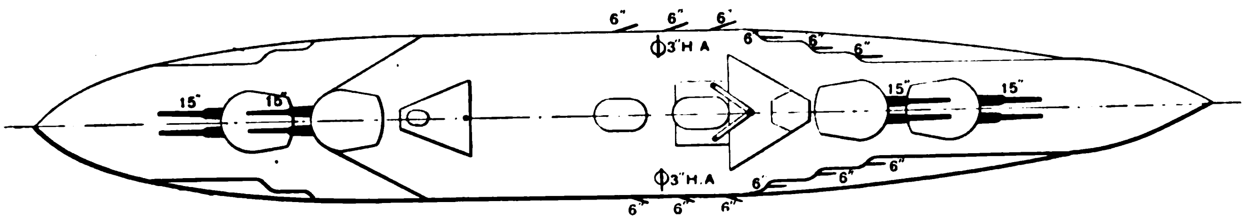
PLATE 2.

## GREAT BRITAIN.

### BATTLESHIPS.

**Queen Elizabeth. Warspite. Barham. Valiant. Malaya.**



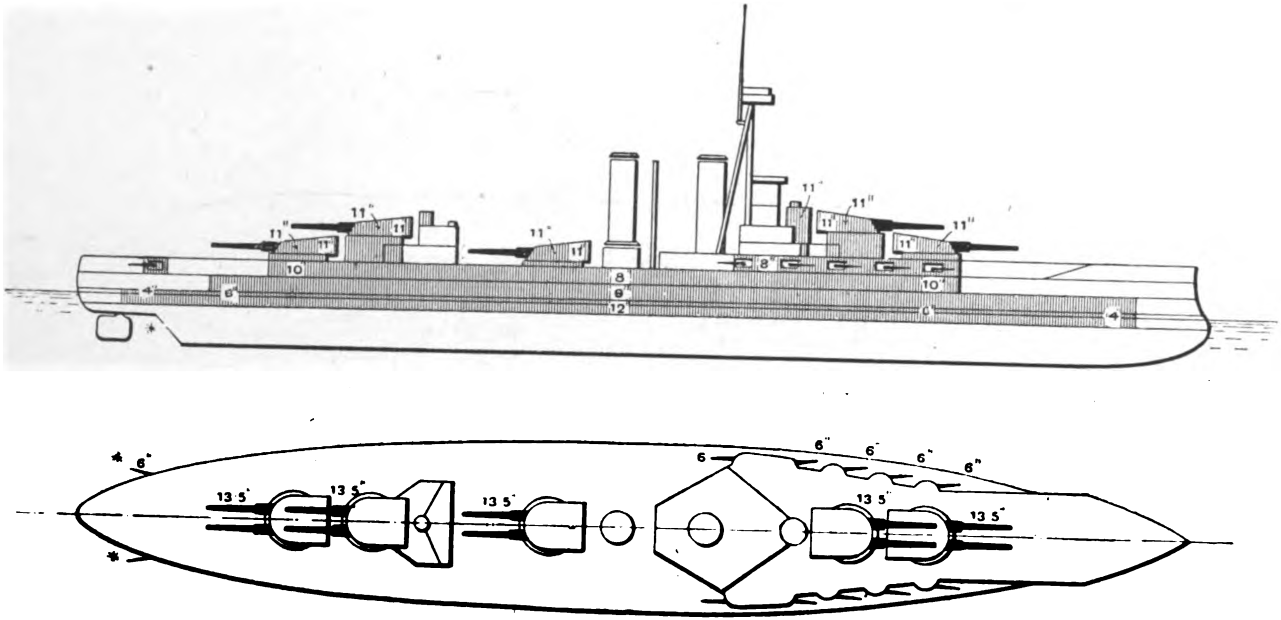




Length, 600 ft.; 27,500 tons; Speed, 25 knots; Completed, 1915-1916;
Armament, 8—15 in., 12—6 in., 2—3 in. H.A., 4—3 pr., 5 M.

# GREAT BRITAIN.

## BATTLESHIPS.

**Iron Duke. Marlborough. Benbow. Emperor of India.**



Length, 580 ft. ; 25,000 tons ; Speed, 21-22 knots ;
Armament, 10—13·5 in., 12—6 in., 2—3 in. A.A., 4—3 pr.

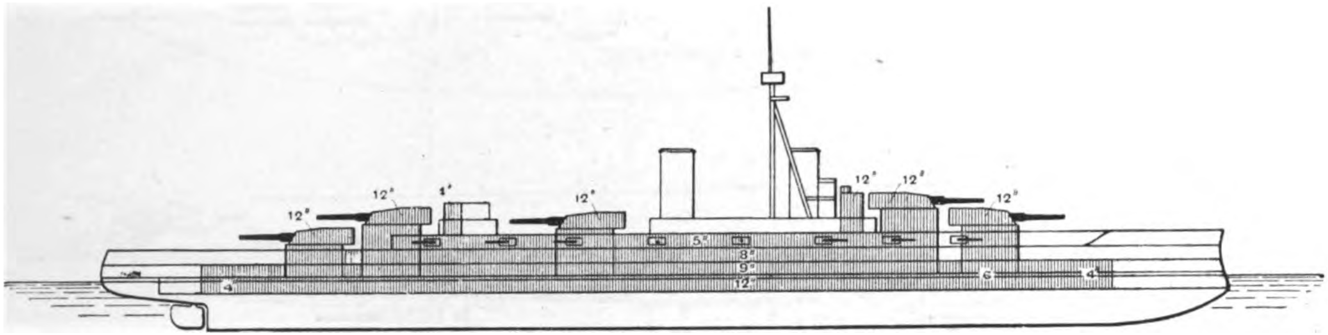
* These two guns have been removed to a position on forecastle abreast foremost funnel.

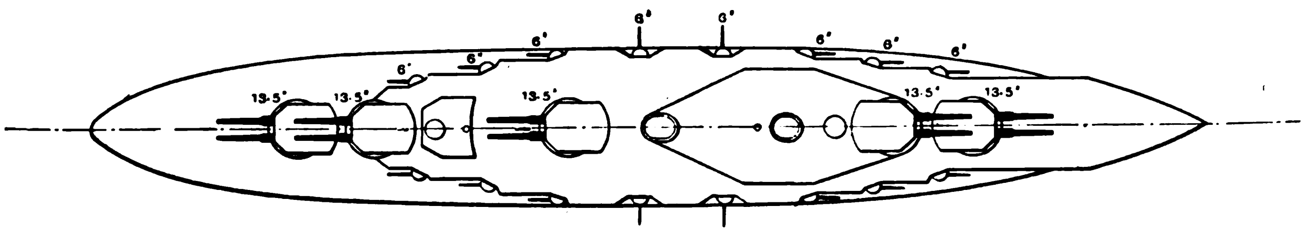
PLATE 4.

GREAT BRITAIN.

BATTLESHIP.

Erin (*Ex* Reshadieh).



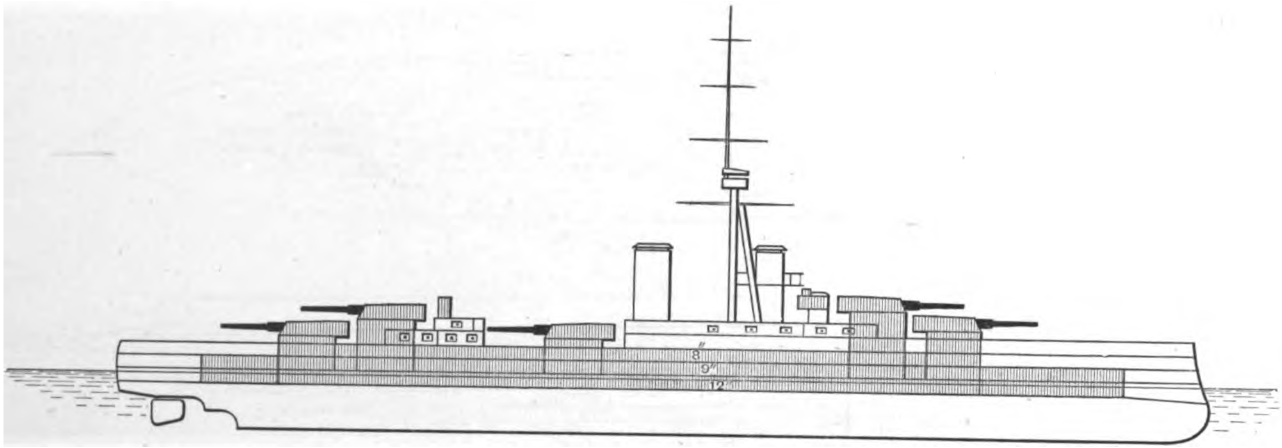



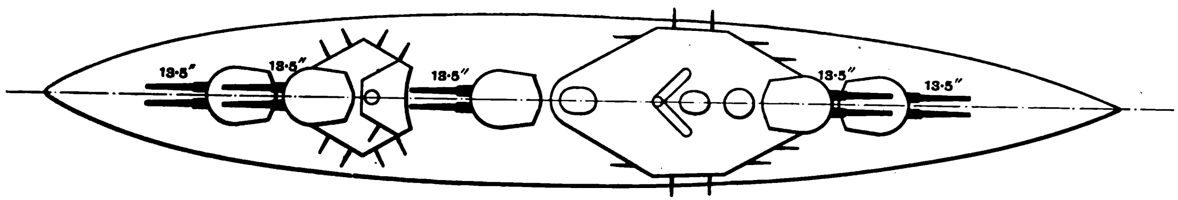

Length, 525 ft. ; 22,940 tons ; Speed, 21·5 knots.
Armament, 10—13·5 in., 16—6 in, 2—3 in. H.A., 4—6 pr.

# GREAT BRITAIN.

## BATTLESHIPS.

Orion. Conqueror. Monarch. Thunderer. Ajax. Centurion. King George.



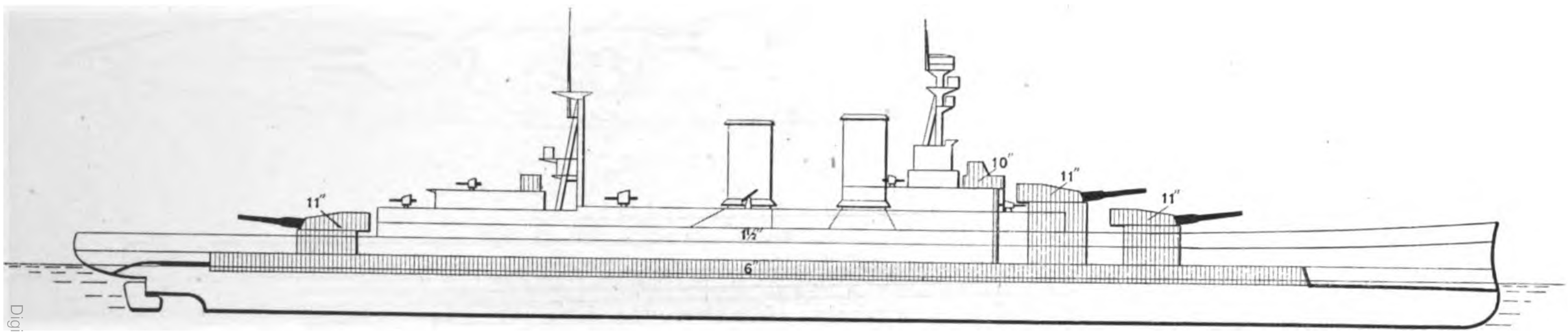

Orion . . . . }
Conqueror . . } Length, 545 ft. ; 22,500 tons ; Speed, 21-22 knots ; Armament, 10—13·5 in., 13—4 in., 4—3 pr., 5 M., and 1—3 in. H.A. ; Completed, 1911-12.
Monarch. . . }
Thunderer . . }

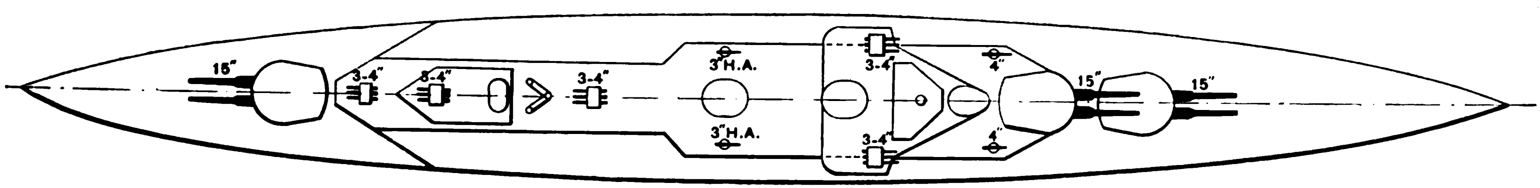
Ajax . . . . }
Centurion . . } Length 555 ft. ; 23,000 tons ; Speed, 22 knots ; Armament, 10—13·5 in., 12—4 in., 4—3 pr., 2—3 in. H.A. ; Completed, 1912-13.
King George V. }

## GREAT BRITAIN.

BATTLE-CRUISERS.

Repulse. Renown.



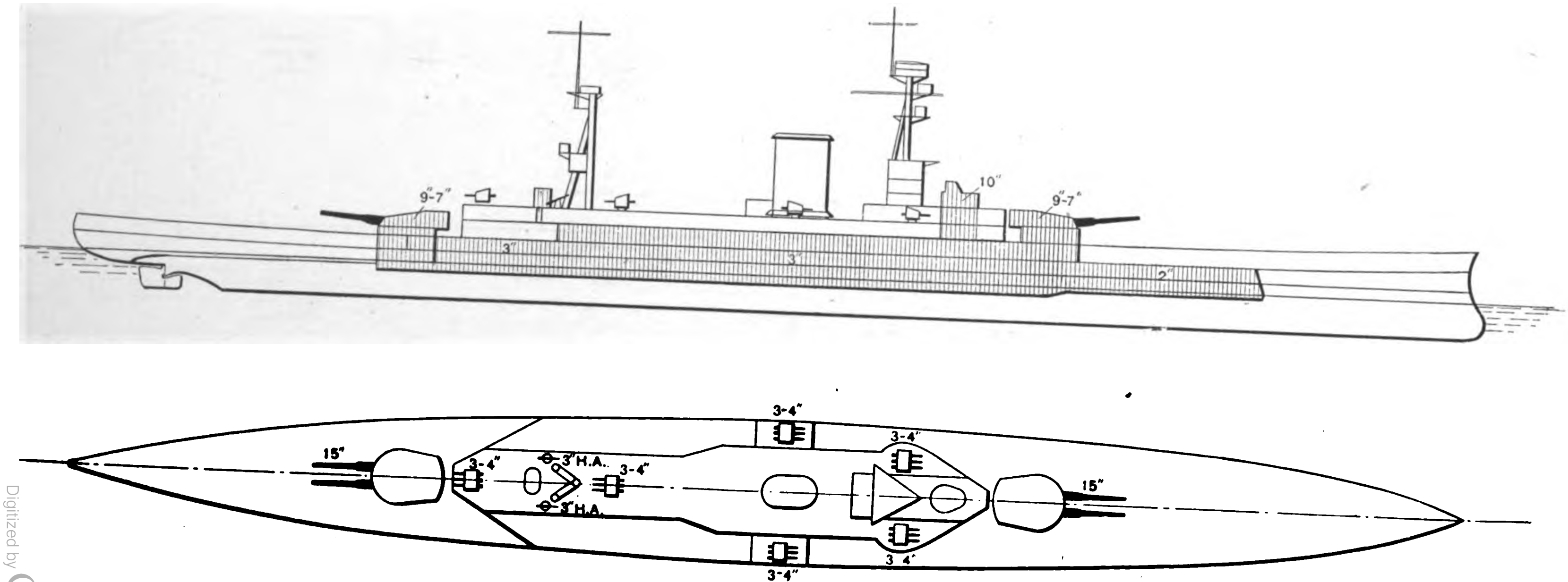

Length, 750 ft.; 26,500 tons; Speed, 32 knots; Completed, 1916; Armament, 6—15 in., 17—4 in., 4—3 pr., 2—3 in. H.A.

Repulse has four additional 4 in. A.A. guns.

# GREAT BRITAIN.

## LARGE LIGHT CRUISERS.

**Courageous.** **Glorious.**

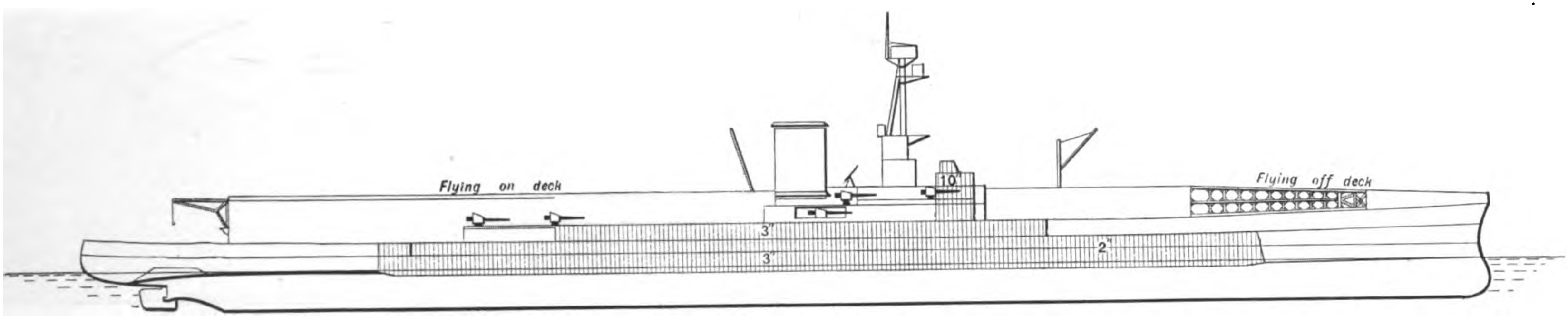


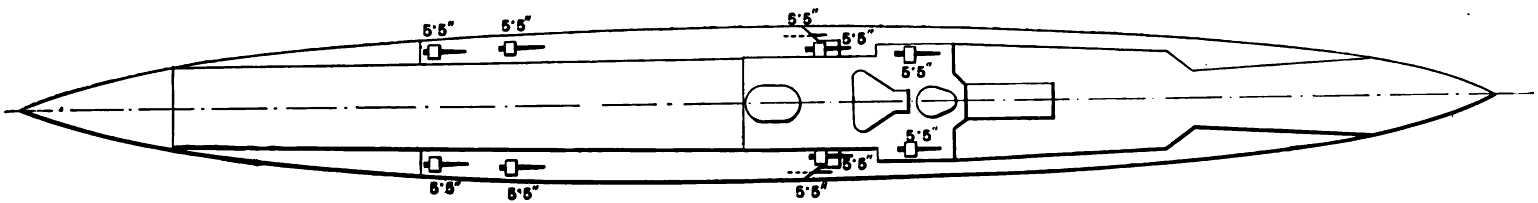

Length, 735 ft.; 18,600 tons; Speed, 32 knots; Completed, 1916; Armament, 4—15 in., 18—4 in., 2—3 in. H.A., 5 M.

## GREAT BRITAIN.

### LARGE LIGHT CRUISER.

**Furious.**
(Seaplane Carrier.)



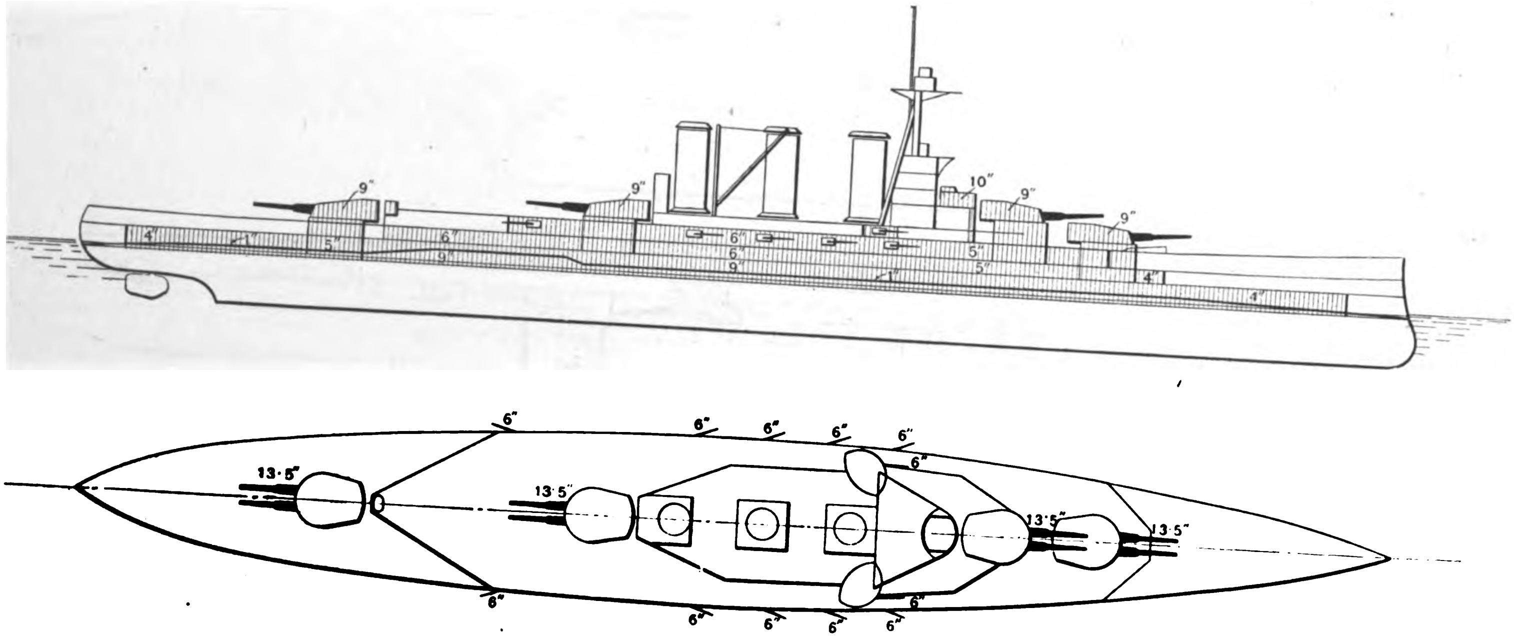




Length, 735 ft.; 19,100 tons; Speed, 31 knots; Completed, 1917;
Armament, 10—5·5 in., 5—3 in. A.A., 2-3 pr.

GREAT BRITAIN.

BATTLE-CRUISER.

Tiger.



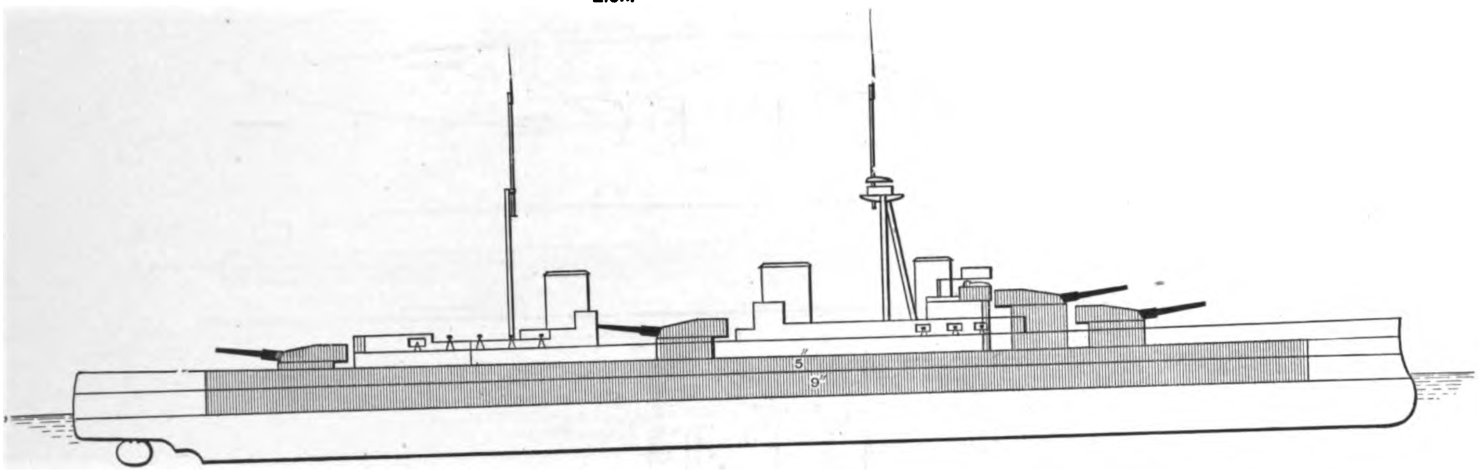

Length, 660 ft. ; 28,500 tons 30 knots ; Completed, 1914 ;
Armament, 8—13·5 in. ; 12—6 in., 4—3 pdr., 5 M., 2—3 in. H.A.

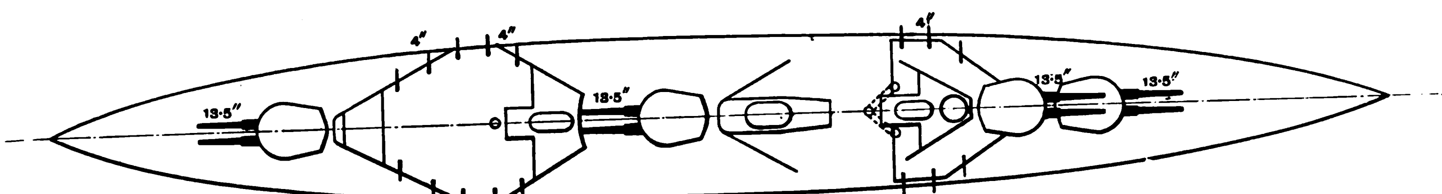
PLATE 10.

# GREAT BRITAIN.

## BATTLE CRUISERS.

**Lion.** **Princess Royal.**



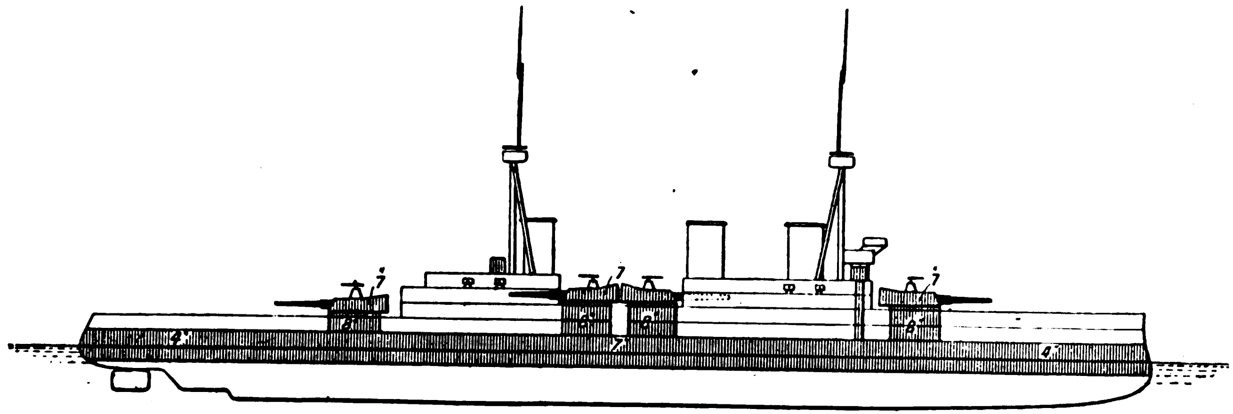

Length, 660 ft. ; 26,350 tons ; Speed, 28-28·5 knots ; Completed, 1912-13 ;
Armament, 8—13·5 in., 16—4 in., 4—3 pr., 5 M., 2—3 in. H.A.

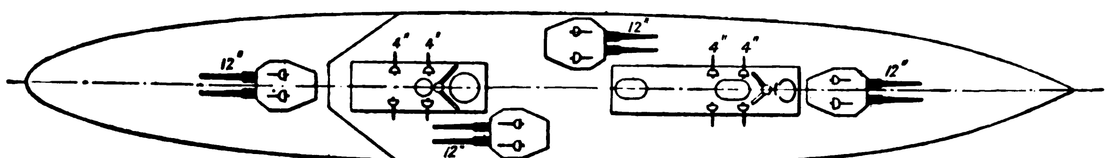
# GREAT BRITAIN.

## BATTLE CRUISERS.

**New Zealand.** **Australia.**

[*All capital ships with 12-in. guns are now regarded as ineffective.*]



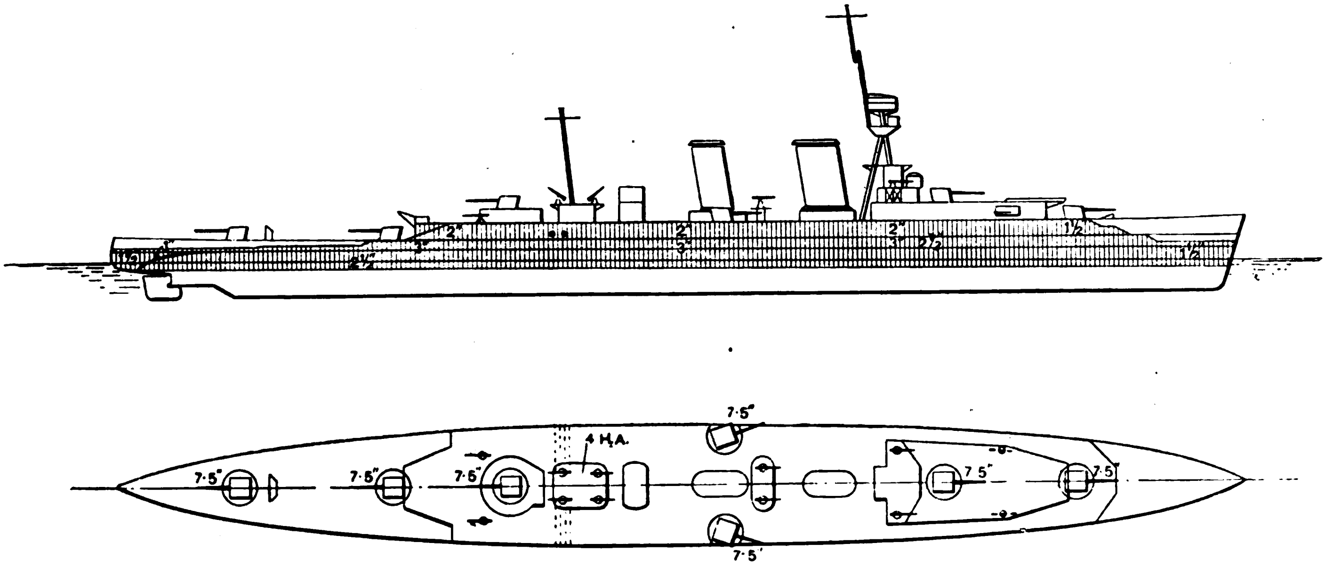

**Length, 555 ft.; 18,800 tons; Speed, 25 knots; Completed, 1913; Armament, 8—12 in., 12—4 in. (New Zealand, 10—4 in.), 4—3 pr., 5 M., 2—4 in. H.A (New Zealand, 1—4 in. H.A.).**

*** The diagrams show also the obsolescent ships Indomitable and Inflexible; but in the New Zealand and Australia the centre turrets are more *en échelon* than in the two earlier ships.**

# GREAT BRITAIN.

## LIGHT CRUISERS.

Raleigh. Effingham. Hawkins. Frobisher.



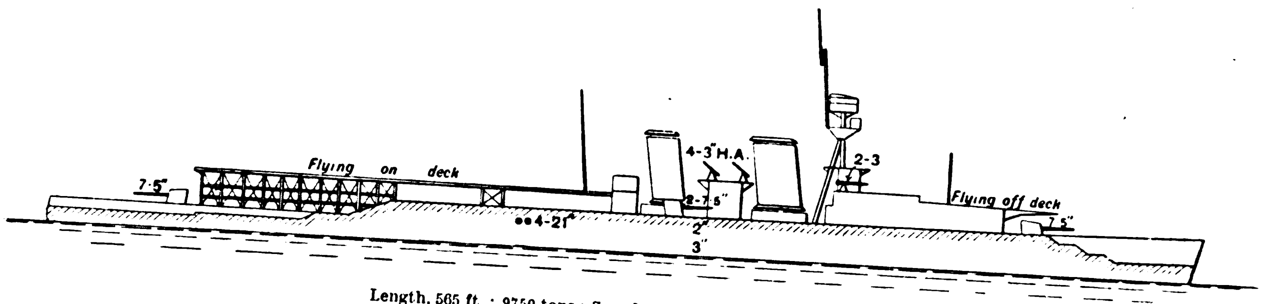

Length, 565 ft. ; 9750 tons ; Speed, 30 knots ;
Armament, 7—7·5 in., 6—3 in., 4—3 in. H.A.

GREAT BRITAIN.

LIGHT CRUISER.

**Vindictive.**

Airplane Carrier.



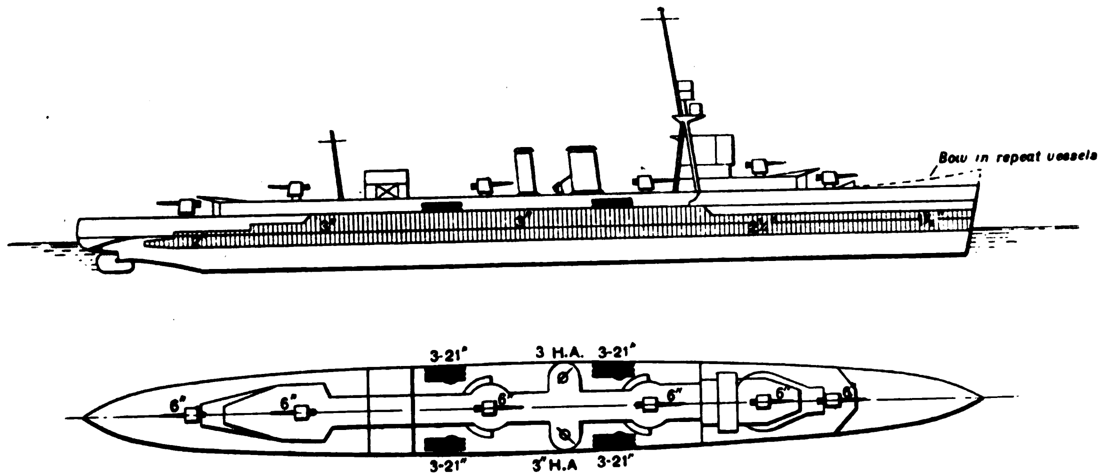

Length, 565 ft.; 9750 tons; Speed, 28·75 knots; Completed, 1918;
Armament, 4—7·5 in., 4—3 in., 4—3 in. H.A.

PLATE 14.

## GREAT BRITAIN.

LIGHT CRUISERS. D CLASS.

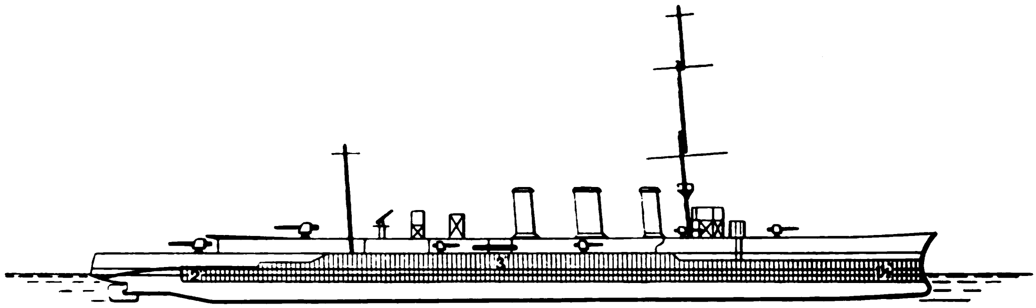
Despatch. Diomede. Danae. Dauntless. Dragon. Delhi. Dunedin. Durban.

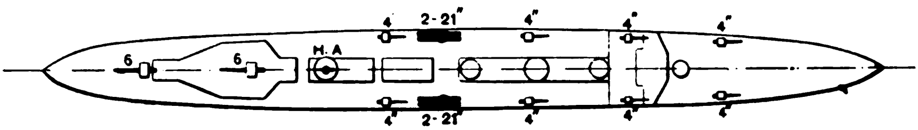



Length, 445 ft.; 4750 tons; Speed, 29 knots;
Armament, 6—6 in., 2—3-in. H.A.

## GREAT BRITAIN.

### LIGHT CRUISERS C CLASS (as originally built).



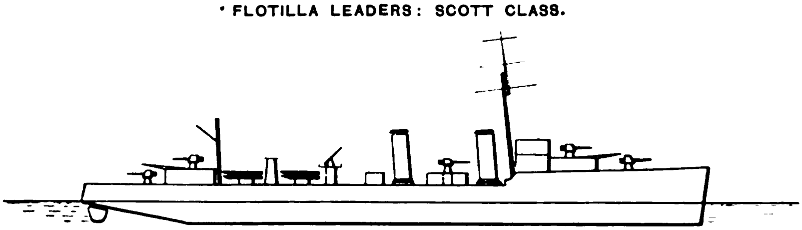


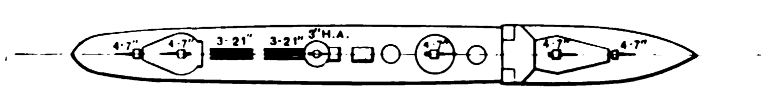

Length, 420–425 ft. ; 3750 tons to 4190 tons ; Speed, 29 knots ;
Armament, 2—6 in. ; 8—4-in. ; 1 H.A.

| | | | | | |
|---|---|---|---|---|---|
| Calliope<br>Conquest<br>Cordelia<br>Carysfort<br>Cleopatra<br>Comus<br>Caroline | 3 funnels | Conning tower and foremast removed since completion and tripod foremast added.<br><br>6-in. gun added on centre-line forward in lieu of 2—4-in.<br><br>6-in. gun added on centre-line amidships in lieu of 4—4-in. guns at waist. | Centaur<br>Concord<br>Caledon<br>Calypso<br>Caradoc | 2 funnels | 5—6-in. guns, all on centre-line, 2—3-in. H.A. |
| Champion<br>Cambrian<br>Canterbury<br>Castor<br>Constance | 2 funnels | | Ceres<br>Curacoa<br>Curlew<br>Cardiff<br>Coventry<br>Cairo<br>Cape Town<br>Carlisle<br>Colombo<br>Calcutta | 2 funnels | 5—6-in. guns on centre-line, arranged as in D class, *i.e.*, end guns superimposed, 2—3-in. H.A. |

NOTE.—Some C class cruisers have submerged tubes only and no above-water tubes.

### FLOTILLA LEADERS: SCOTT CLASS.



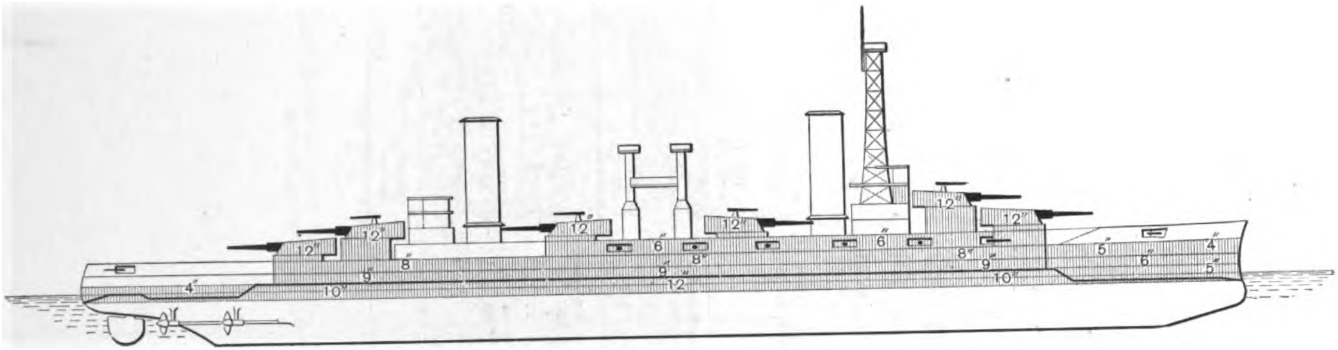


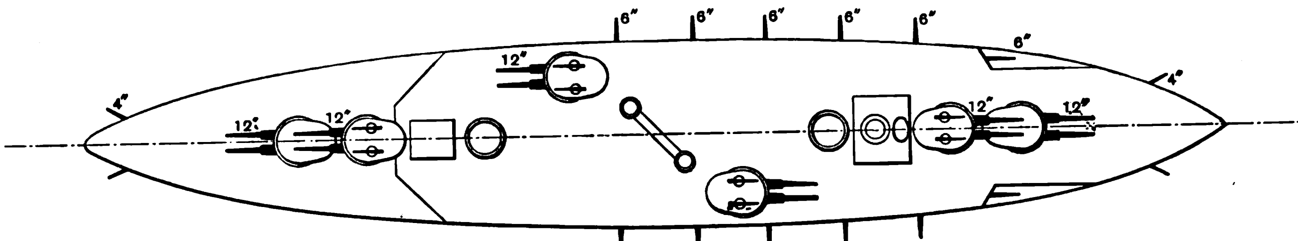

Length, 320 ft. ; 1800 tons ; Speed, 36·5 knots ;
Armament, 5—4·7 in. ; 1—3-in. A.A.

## ARGENTINE.

### BATTLESHIPS.

**Moreno.** **Rivadavia.**



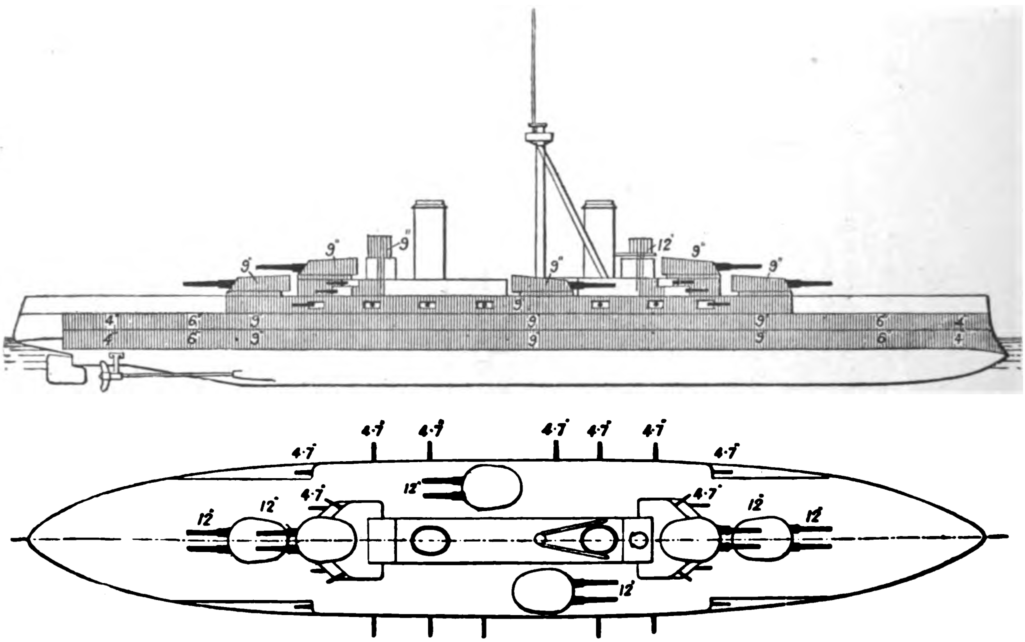




Length, 585 ft.; 27,600 tons; Speed, 22·5 knots; Completed, 1914;
Armament, 12—12 in., 12—6 in., 16—4 in., 10 smaller.

# BRAZIL.

## BATTLESHIPS.

**Minas Geraes.** **São Paulo.**

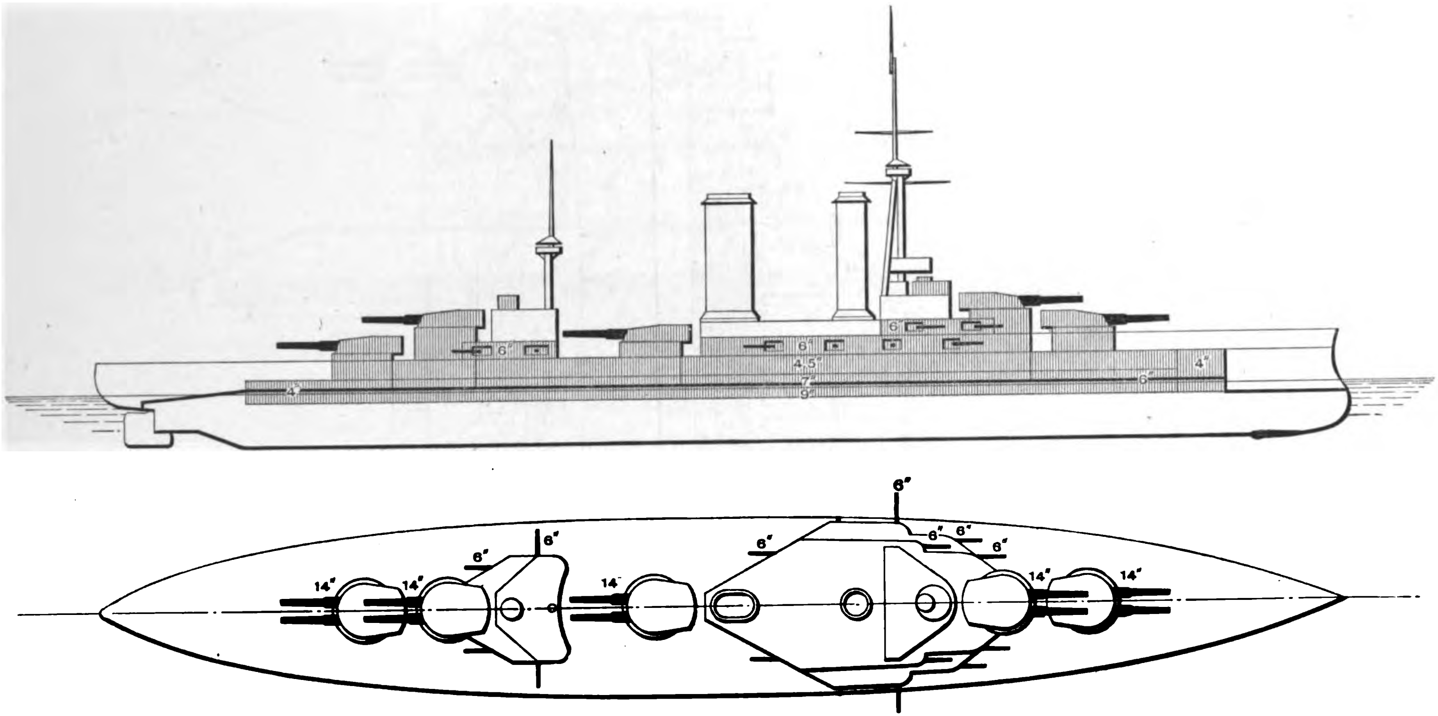



**Length, 500 ft. ; 19,281 tons ; Speed, 21·5 knots ; Completed, 1909, 1910 ;**
**Armament, 12—12 in., 22—4·7 in., 8—3 pr.**

## CHILE.

BATTLESHIP.

**Almirante Latorre** (*formerly* **H.M.S. Canada**).

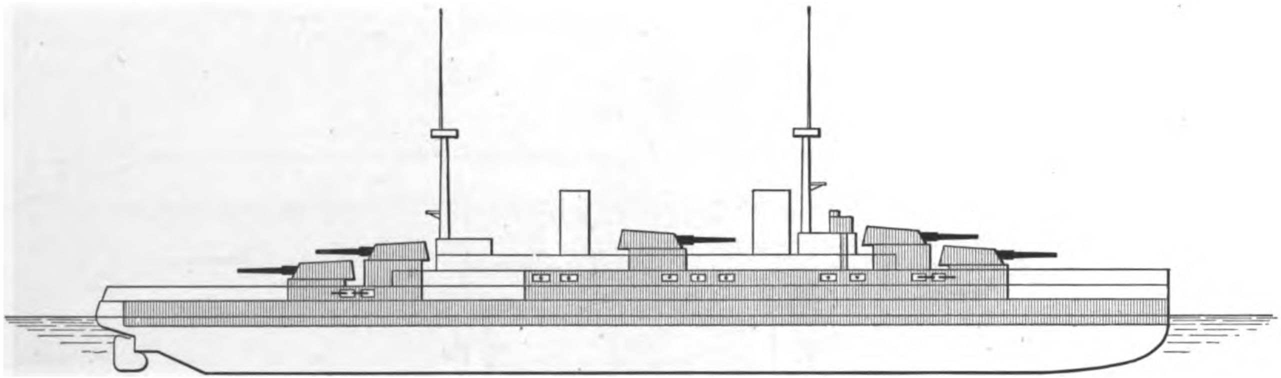


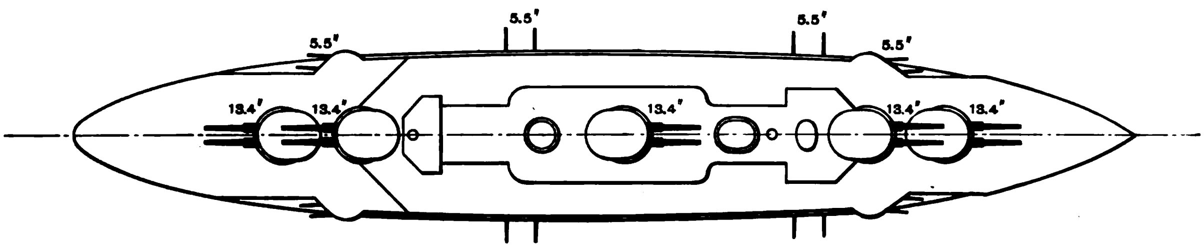

Length, 625 ft.; 28,000 tons; Speed, 23 knots;
Armament, 10—14 in.; 14—6 in.; 6—3 in., and smaller.

# FRANCE.

## BATTLESHIPS.

Bretagne. Lorraine. Provence.



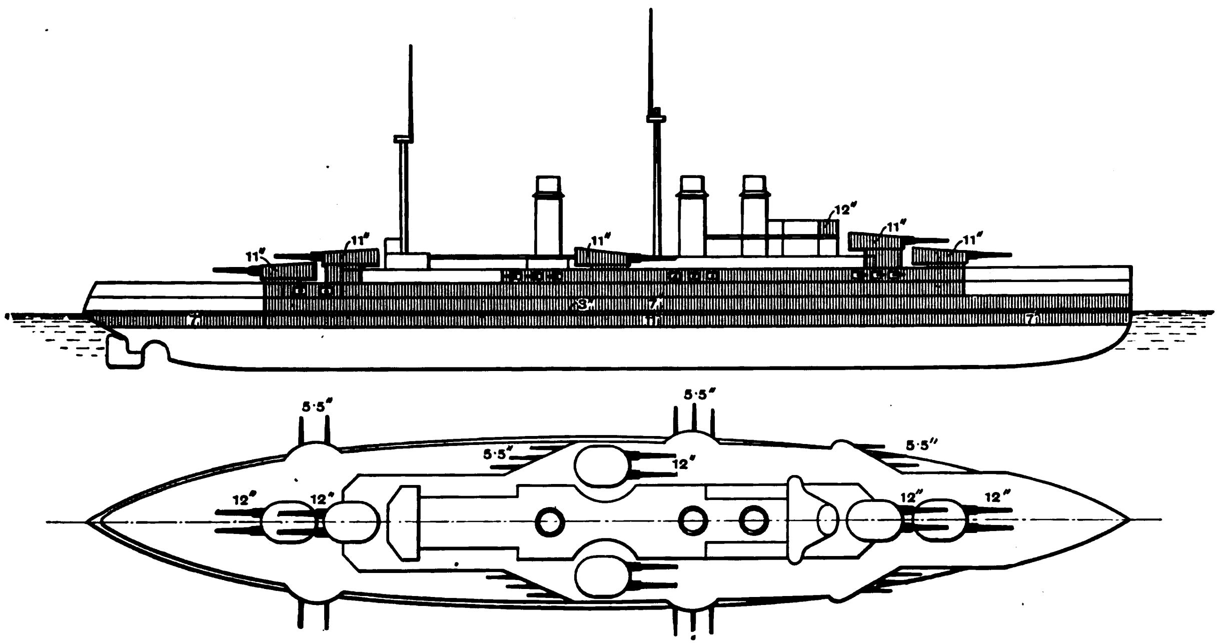



Length, 546 ft.; 23,177 tons; Speed, 20 knots;
Armament, 10—13·4 in., 18—5·5 in., 8 small.

# FRANCE.

## BATTLESHIPS.

Jean Bart. Courbet. France. Paris.



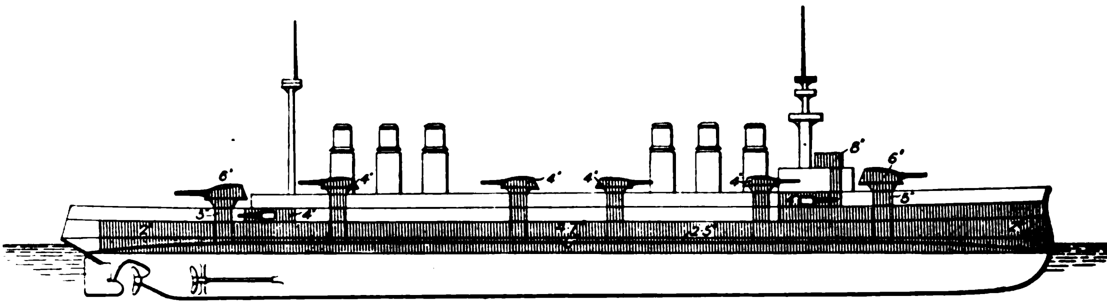

Length, 546 ft.; 23,100 tons; Speed, 20 to 22 knots; Completed, 1913–16;
Armament, 12—12 in., 22—5·5 in., 4—3 pr.

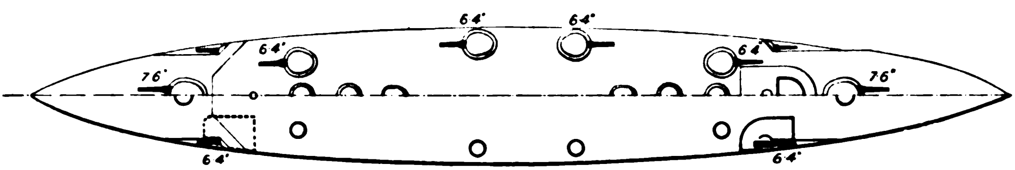
(Tonnage varies between 23,100 and 23,467 tons.)

## FRANCE.

### ARMOURED CRUISERS.

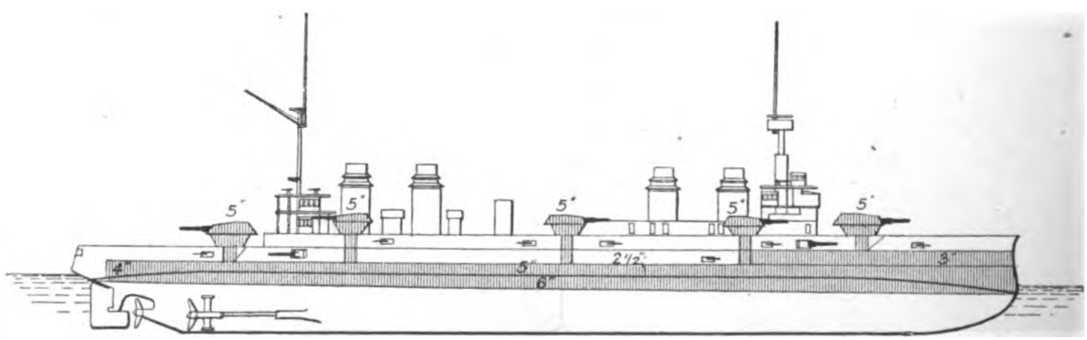
**Ernest Renan. Jules Michelet.**

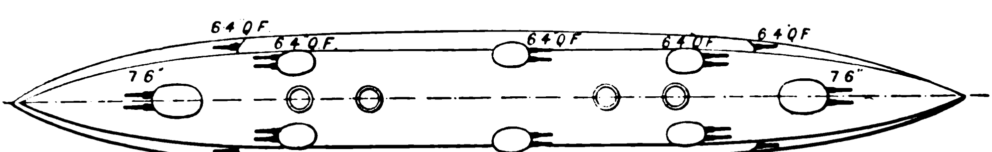



Length, 515 ft. and 489½ ft.; 13,427 tons and 13,370 tons; Speed, 25·5 knots and 23·2 knots; Completed, 1909 and 1908; Armament, 4—7·6 in., 12—6·4 in., 24 small (only 2 small guns in Jules Michelet).
The Jules Michelet has only four funnels.

**Jules Ferry. Victor Hugo.**



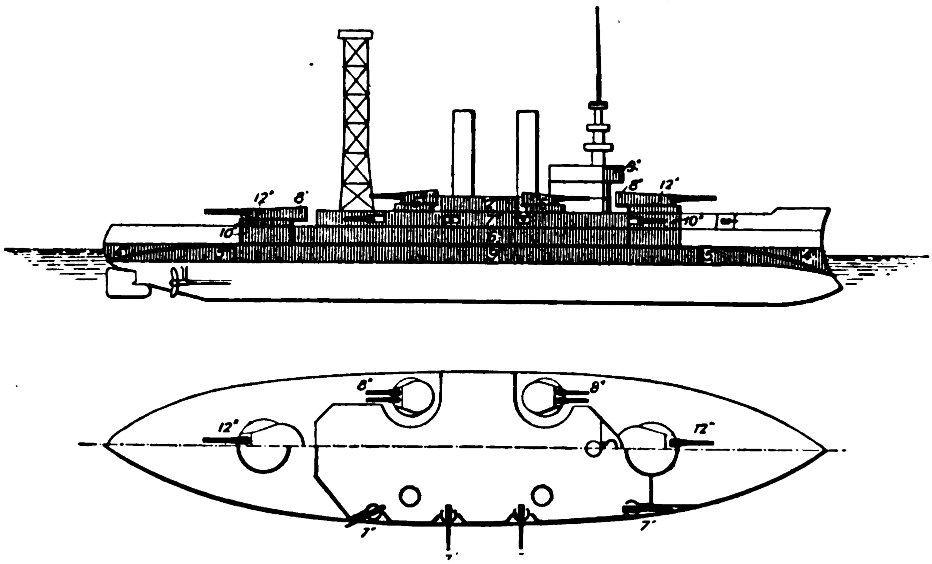




Length, 487 ft. and 480·5 ft.; 12,351 and 13,108 tons; Speed, 22·8 and 22·5 knots; Completed, 1906–1907; Armament, 4—7·6 in., 16—6·4 in., 24 small.

# GREECE.

## BATTLESHIPS.

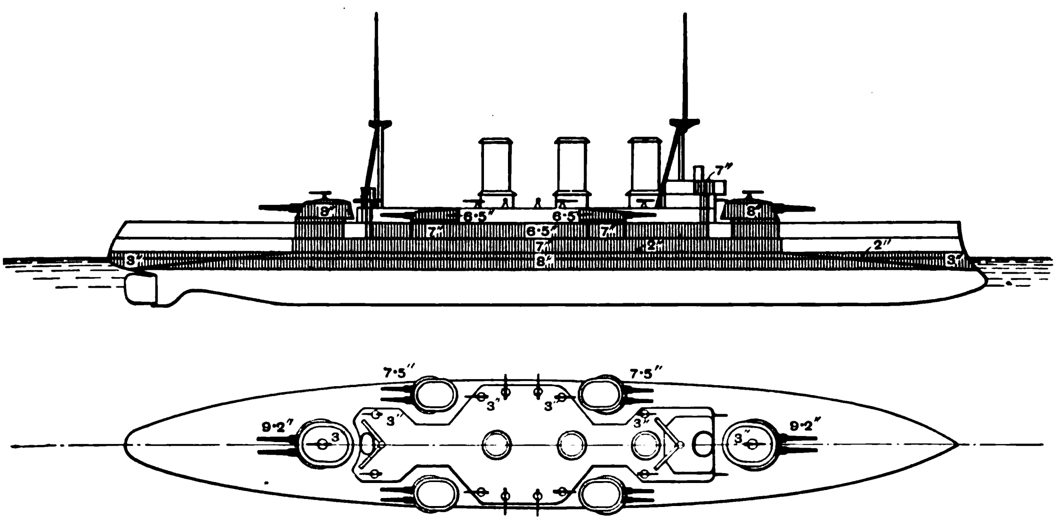
**Lemnos** (*ex*-**Idaho**). **Kilkis** (*ex*-**Mississippi**).



Length, 375 ft. ; 13,000 tons ; Speed, 17·1 knots ; Completed, 1908 ;
Armament, 4—12 in., 8—8 in., 8—7 in., 12—3 in., 14 small.

## ARMOURED CRUISER.

**Giorgios Averoff.**

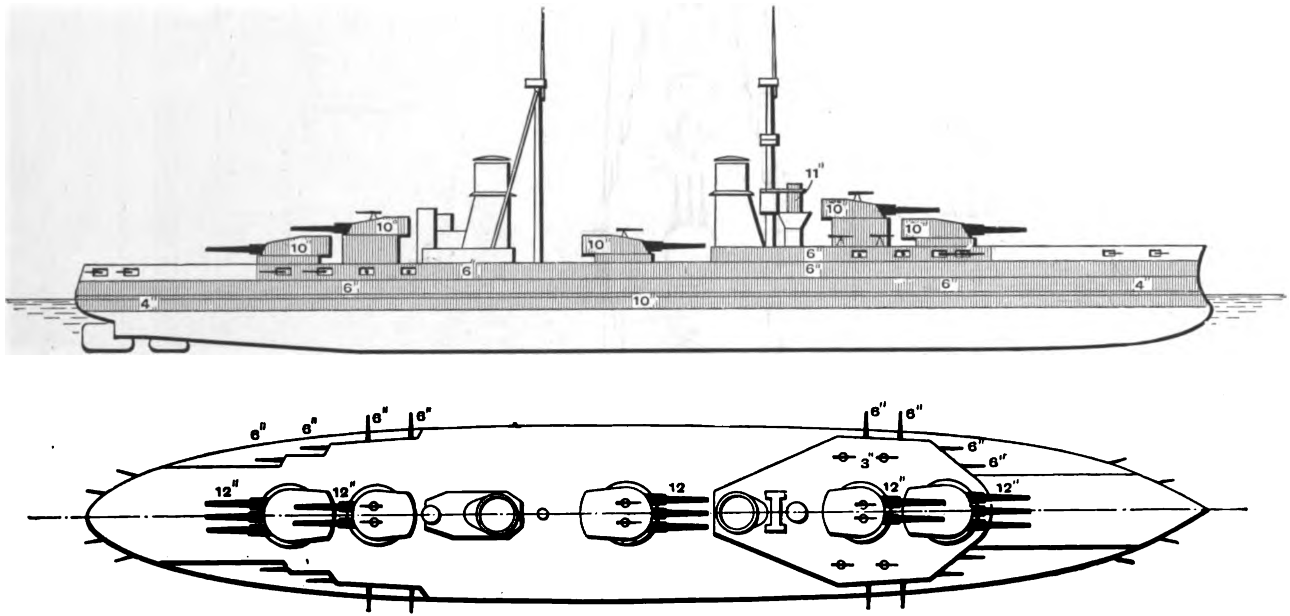


Length, 429¾ ft. ; 9956 tons ; Speed, 24 knots ; Completed, 1911 ;
Armament, 4—9·2 in., 8—7·5 in., 16—3 in., 8 small.

# ITALY.

## BATTLESHIPS.

**Andrea Doria.** **Caio Duilio.**



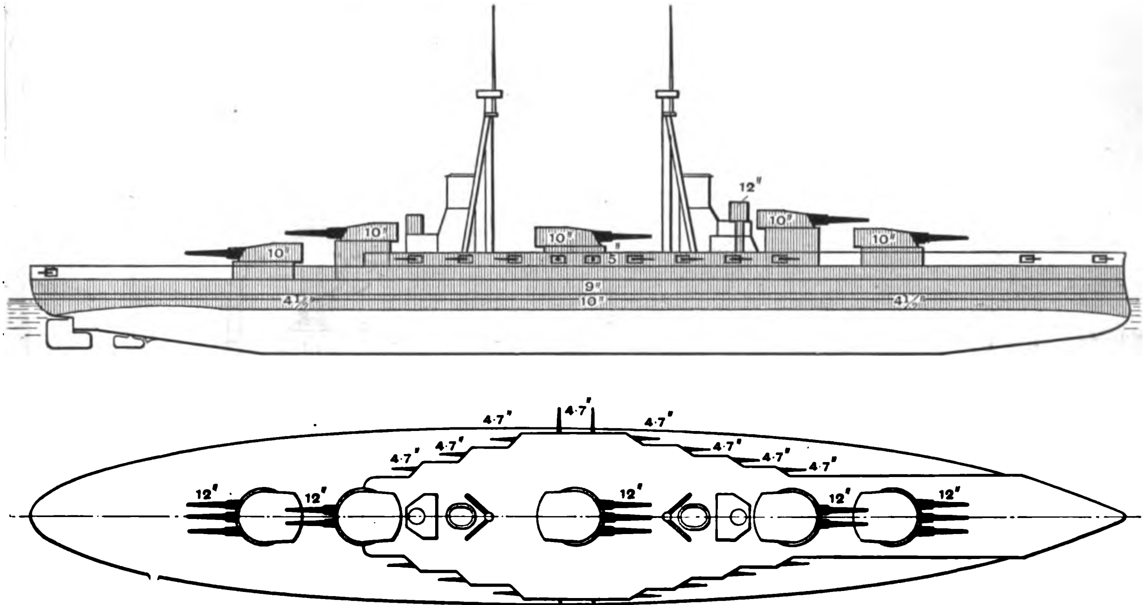

Length, 575¾ ft. ; 22,562 tons ; Speed, 23 knots ; Completed 1915 ;
Armament, 13—12 in., 16—6 in., 14—14 pr., 4 l. and M., 6—14 pr. H.A.

N.B.—In the next succeeding class, Francesco Morosini, Caracciolo, Cristoforo Colombo, and Marcantonio Colonna, eight 15-in. guns were being mounted in four turrets on the middle line, as in the Queen Elizabeth. Work on these vessels has been stopped.

# ITALY.

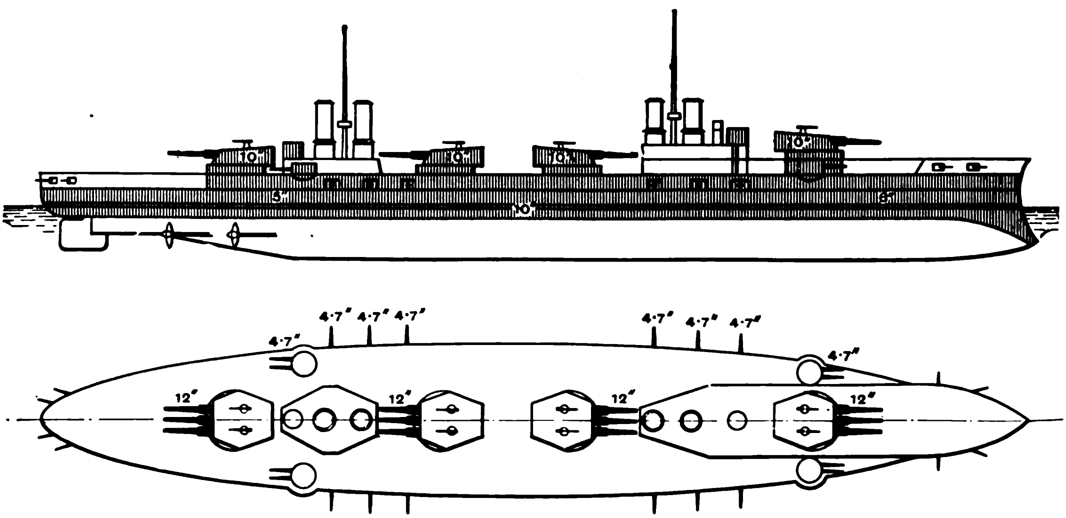
## BATTLESHIPS.

### Conte di Cavour. Giulio Cesare.




Length, 557 ft. ; 22,023 tons ; Speed, 22–23 knots ; Completed, 1914, 1915 ;
Armament, 13—12 in., 18—4·7 in., 14—12 pr.

### Dante Alighieri.

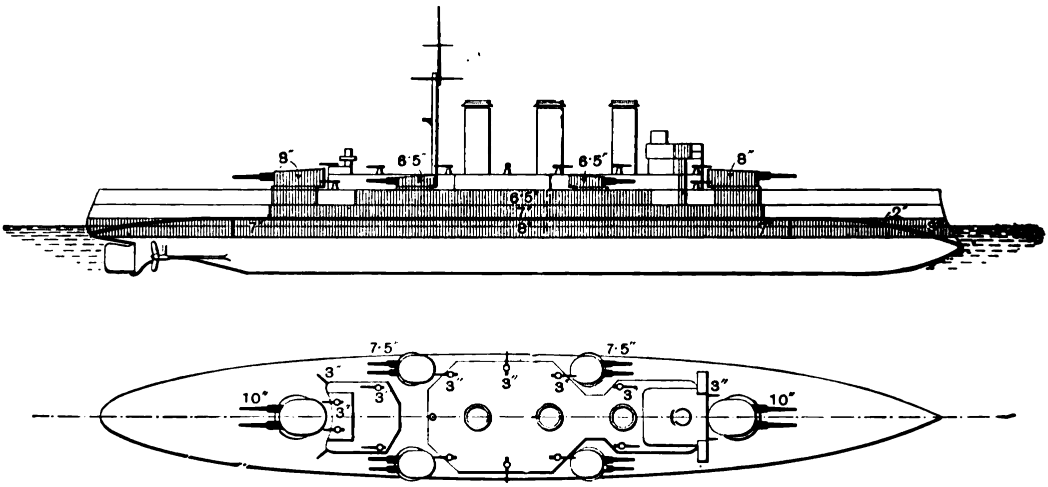



Length, 505 ft. ; 19,400 tons ; Speed, 23·8 knots ; Completed, 1912 ;
Armament, 12—12 in. 20—4·7 in., and 14—12 pr.

## ITALY.

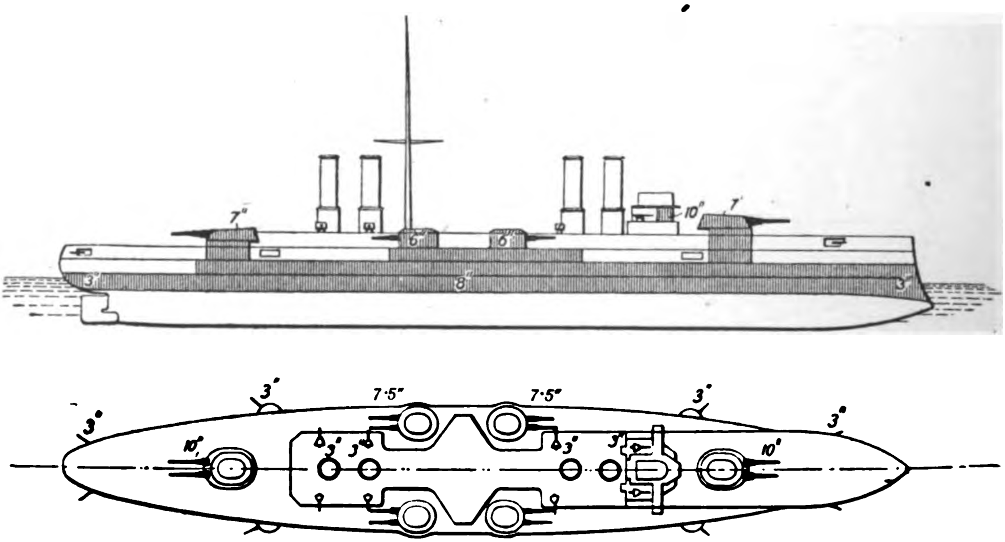
### ARMOURED CRUISERS.

**Pisa.**




**Length, 429¾ ft. ; 9956 tons ; Speed, 23 knots ; Completed, 1908 ;**
**Armament, 4—10 in., 8—7·5 in., 16—3 in., 8 small.**

**S. Giorgio. S. Marco.**



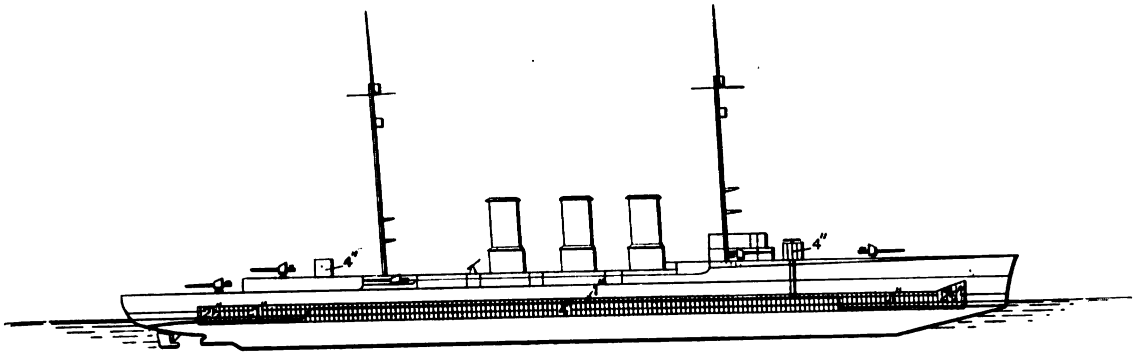

**Length, 429¾ ft. ; 9832 tons ; Speed, 22·5 knots ; Completed, 1910 ;**
**Armament, 4—10 in., 8—7·5 in., 16—3 in., 4 small.**

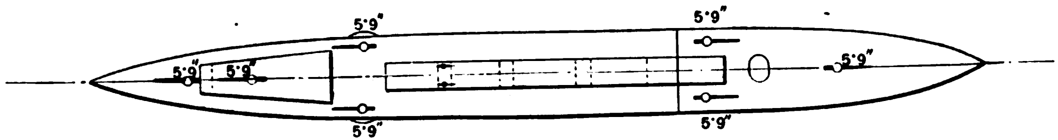
# ITALY.

## LIGHT CRUISER.

**Ancona** (*formerly German* **Graudenz**).

(The sister ship **Regensburg** was allocated to France, and is now named **Strasbourg**.)



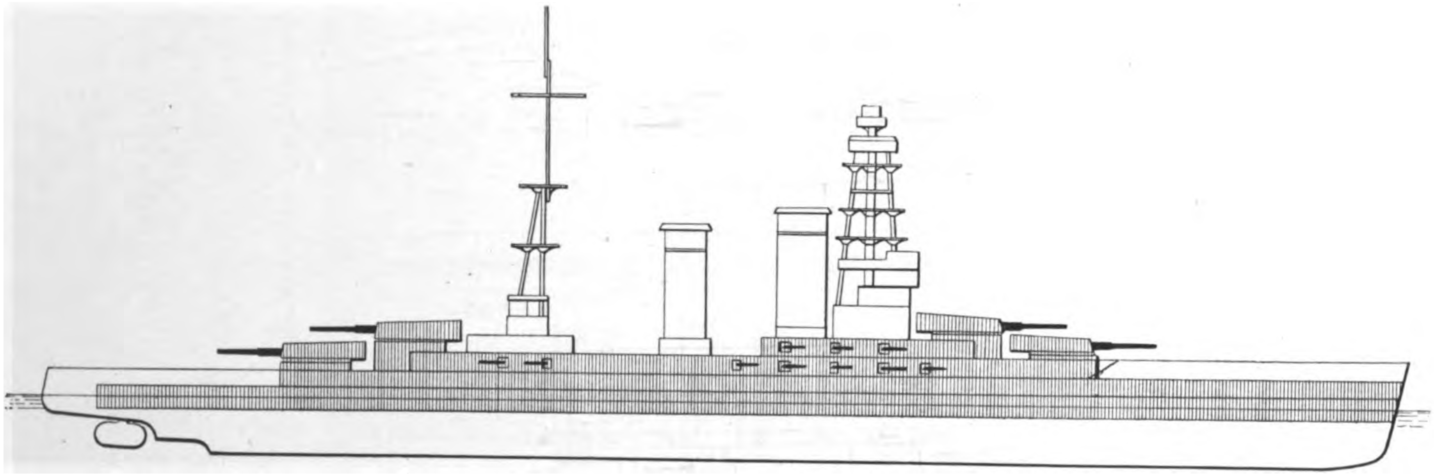

Length, 456 ft.; 4842 tons; Speed, 27½ knots; Completed, 1914;
Armament, 7—5·9 in., 2—22 pr., 2 M.

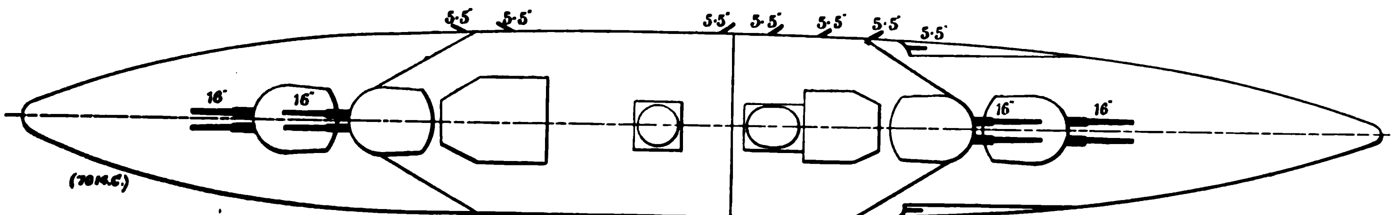
NOTE.—The above are typical of the latest *ex*-German Light Cruisers, except the mine-laying cruisers Brummer and Bremse, in which no armour belt was fitted and an all-centre-line armament adopted.

JAPAN.

BATTLESHIP.

Nagato.



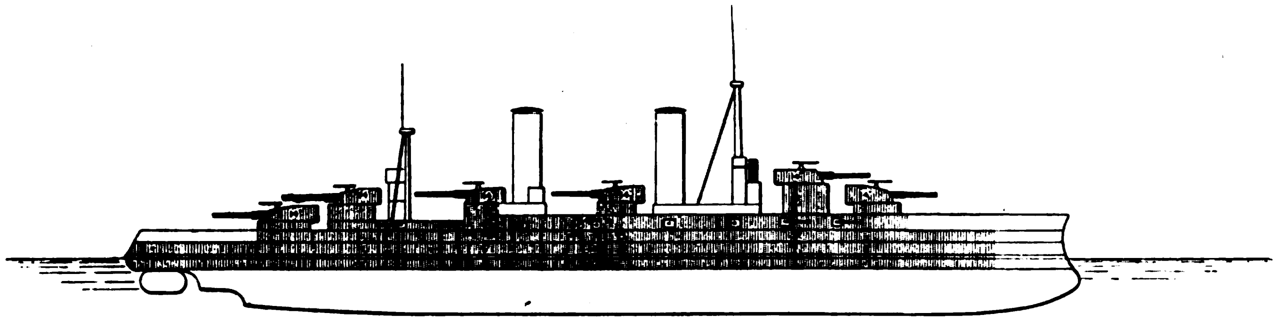


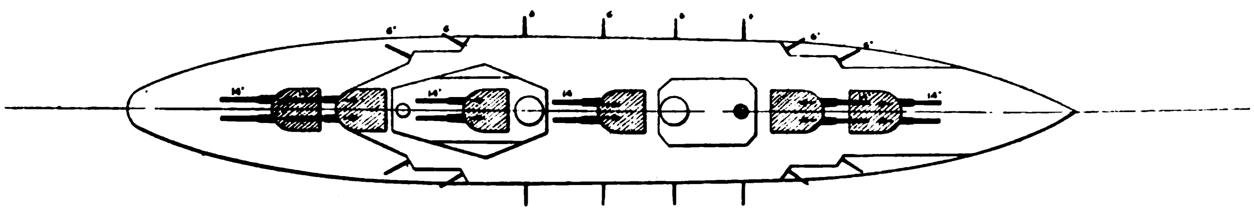

Length, 700 ft.; 33,800 tons; Speed, 23·5 knots; Completed, 1920;
Armament, 8—16 in., 20—5·5-in., 4—12 pr. A.A.

## JAPAN.

### BATTLESHIPS.

**Fuso.** **Yamashiro.**






Length, 630 ft.; 30,600 tons; Speed, 23 knots; Completed 1915—1917;
Armament, 12—14-in., 16—6-in., 4—12 pr. A.A.

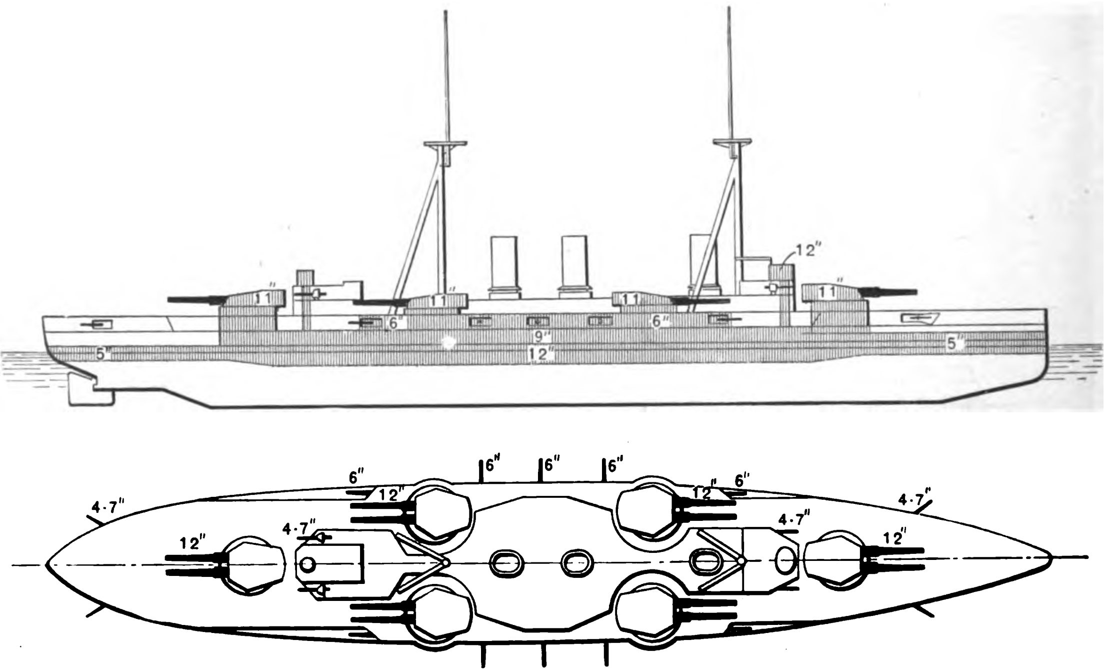
NOTE.—The armour on the turrets is 12 in., not 14 in. as shown, and, owing to an oversight in the drawing, the armoured substructure of the conning-tower is not shown; also the water-line belt is continued to the bows.

The sister ships Hyuga and Ise have superposed turret amidships, and the secondary guns are grouped forward, excepting four, which fire astern.

# JAPAN.

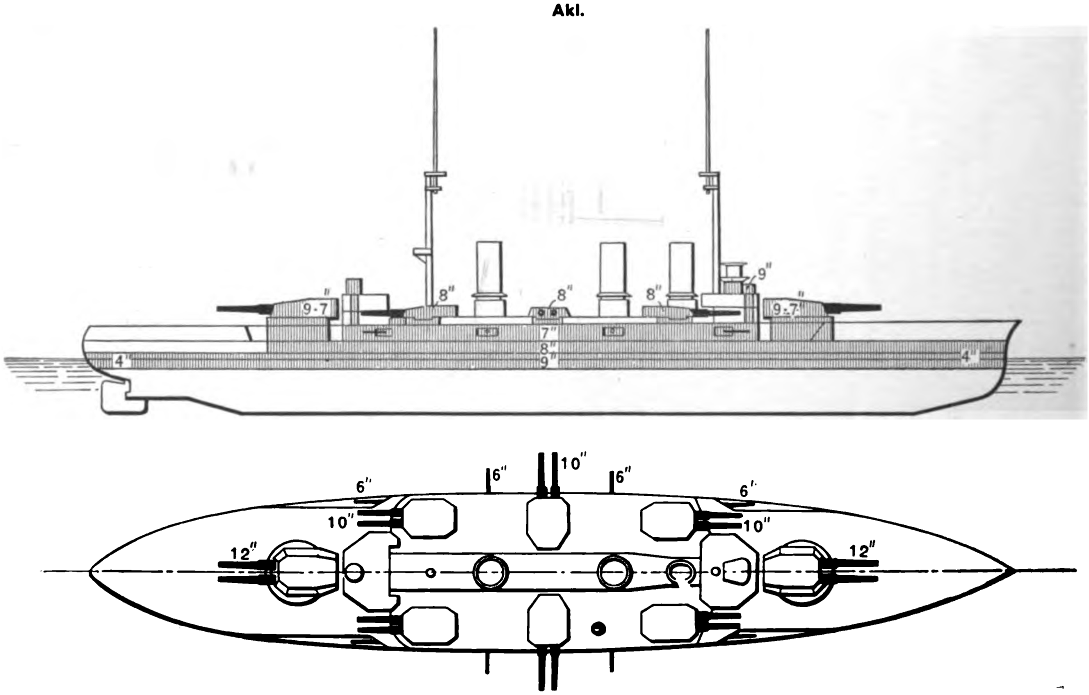
## BATTLESHIPS.

### Settsu.




Length, 500 ft. ; 20,800 tons ; Speed, 20·5 knots ; Completed, 1912 ;
Armament, 12—12 in., 10—6 in., 8—4·7 in., 16 small.

### Akl.

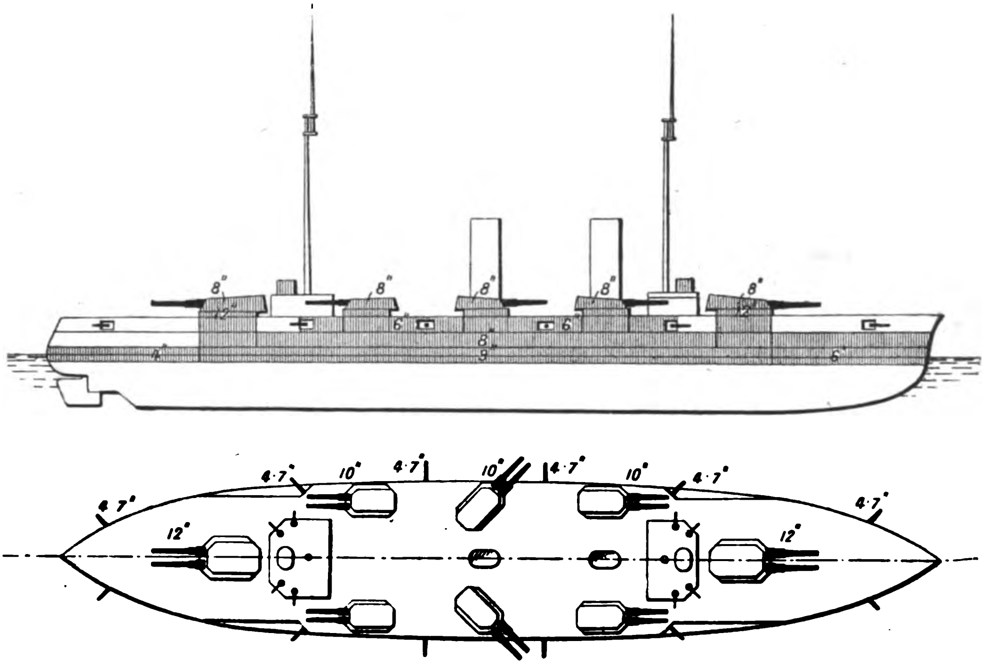



Length, 460 ft. ; 19,800 tons ; Speed, 20·5 knots ; Completed, 1910 ;
Armament, 4—12 in., 12—10 in., 8—6 in., 8—12 pr., 8 small.

## JAPAN.

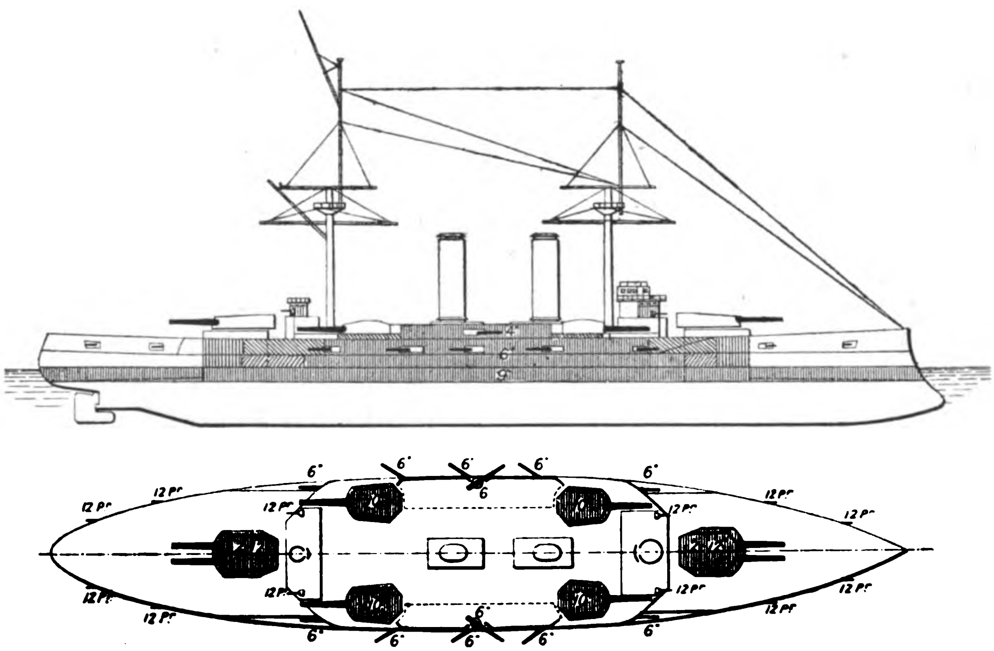
### BATTLESHIPS.

**Satsuma.**




**Length, 450 ft. ; 19,350 tons ; Speed, 18·5 knots ; Completed, 1910 ;**
**Armament, 4—12 in., 12—10 in., 12—4·7 in., 4—12 pr., 8 small.**

**Katori. Kashima.**

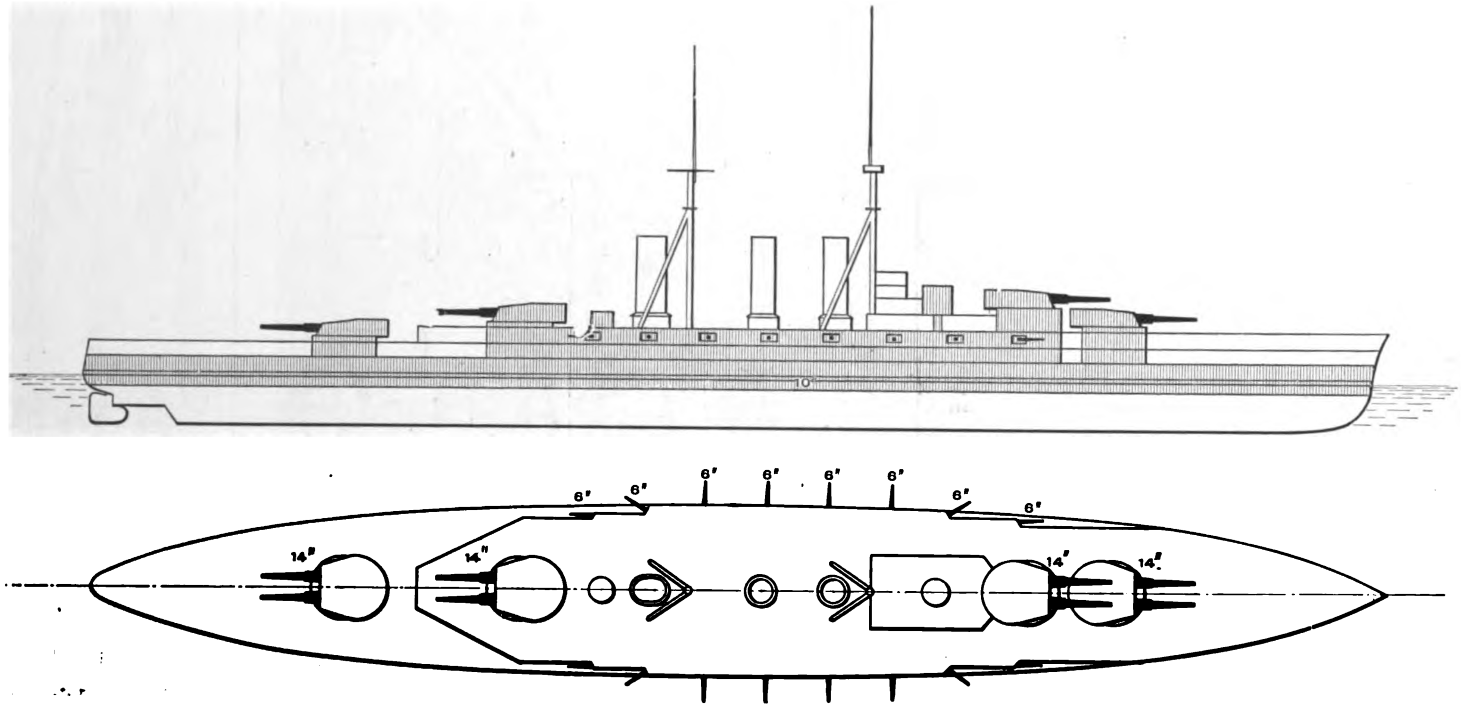



**Length, 420–425 ft. ; 15,975-16,400 tons ; Speed, 19·5 knots ; Completed, 1906 ;**
**Armament, 4—12 in., 4—10 in., 12—6 in., 12—12 pr., 7 small.**

## JAPAN.

### BATTLE-CRUISERS.

**Kongo. Hiyei. Haruna. Kirishima.**

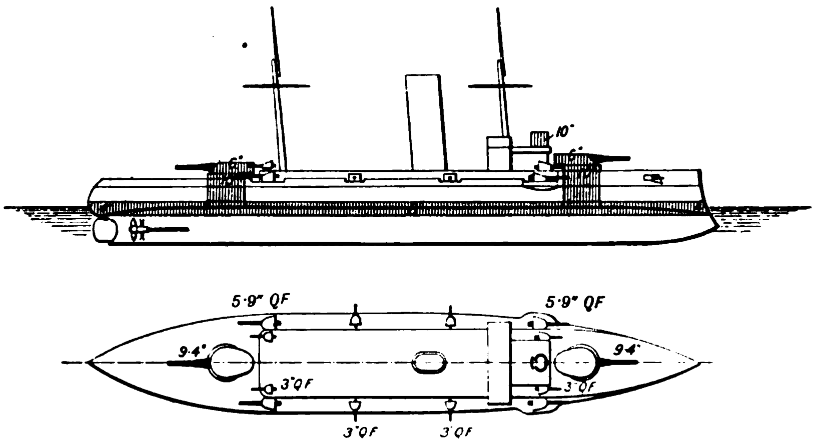



**Length, 653½ ft.; 27,500 tons; Speed, 27·5 knots; Completed, 1913–1915; Armament, 8—14 in., 16—6 in., 4—12 pr. H.A.**

## NETHERLANDS.

### COAST DEFENCE SHIPS.

**De Ruyter.** **Hertog Hendrik.** **Koningin Regentes.** **Marten Tromp.**

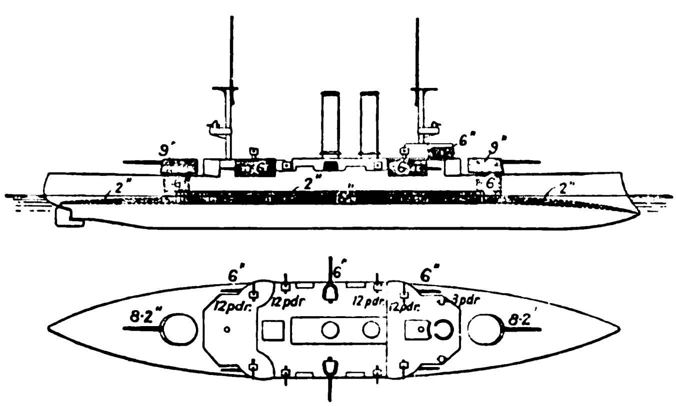



**Length, 316¾ ft. ; 5000—5216 tons ; Speed, 16·5 knots ; Completed, 1902—1906 ;**
**Armament, 2—9·4 in., 4—5·9 in., 10—2·9 in., 4 small.**

## NORWAY.

### COAST DEFENCE SHIPS.

**Norge.** **Eidsvold.**

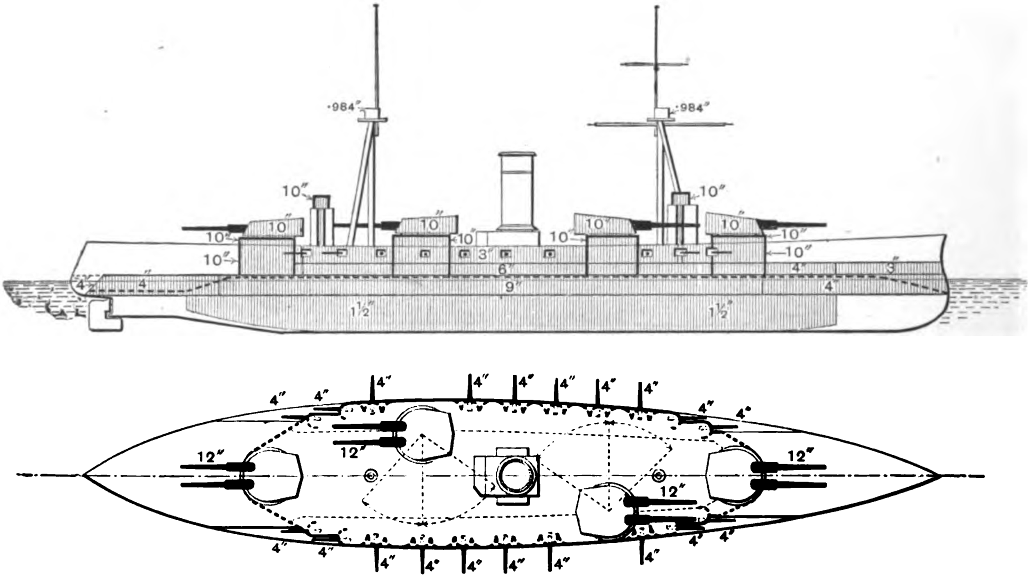



**Length, 290 ft. ; 4233 tons ; Speed, 16·9 knots ; Completed, 1901 ;**
**Armament, 2—8·2 in., 6—6 in., 8—12 pr., 6 small.**

## SPAIN.

### BATTLESHIPS.

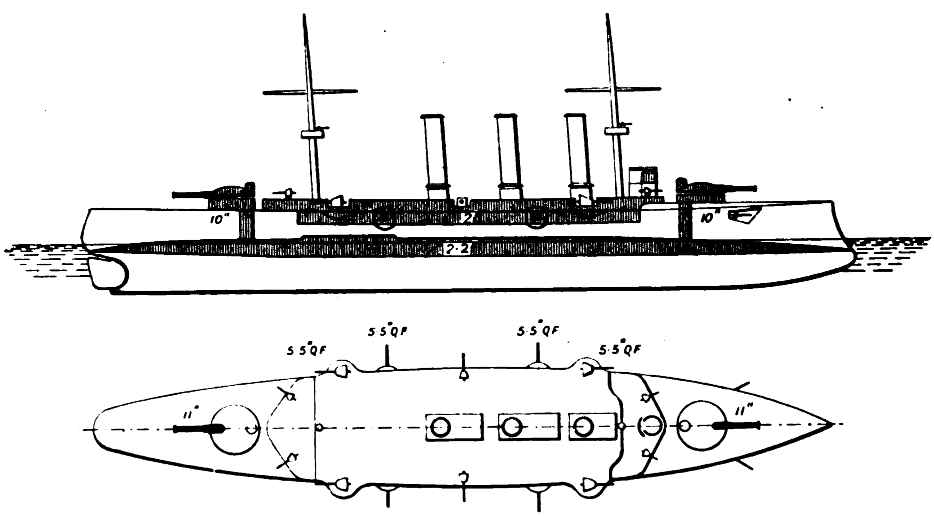
**Alphonso XIII. España. Jaime I.**




Length, 435 ft. ; 15,460 tons ; Speed, 19·5 knots to 20·5 knots ; Completed, 1913-1916 ;
Armament, 8—12 in., 20—4 in.; 6 small.

### ARMOURED CRUISER.

**Emperador Carlos V.**

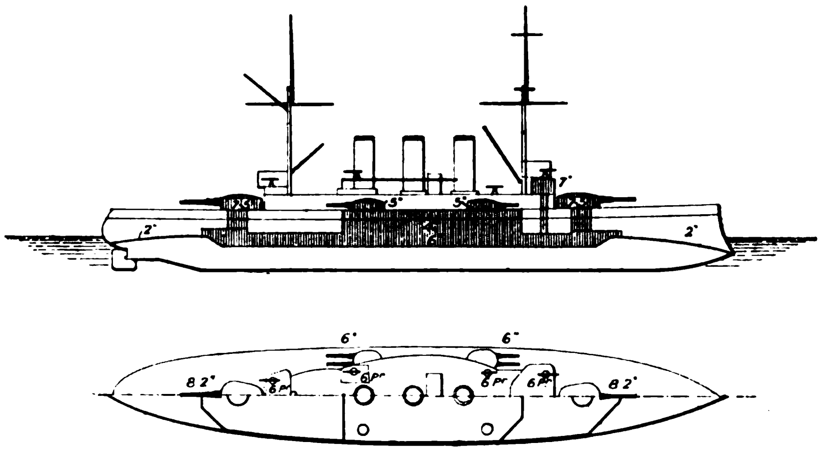



Length, 380 ft. ; 9089 tons ; Speed, 19 knots ; Completed, 1898 ;
Armament, 2—11 in., 8—5·5 in., 4—3·9 in., 7 small.

# SWEDEN.

## BATTLESHIP.

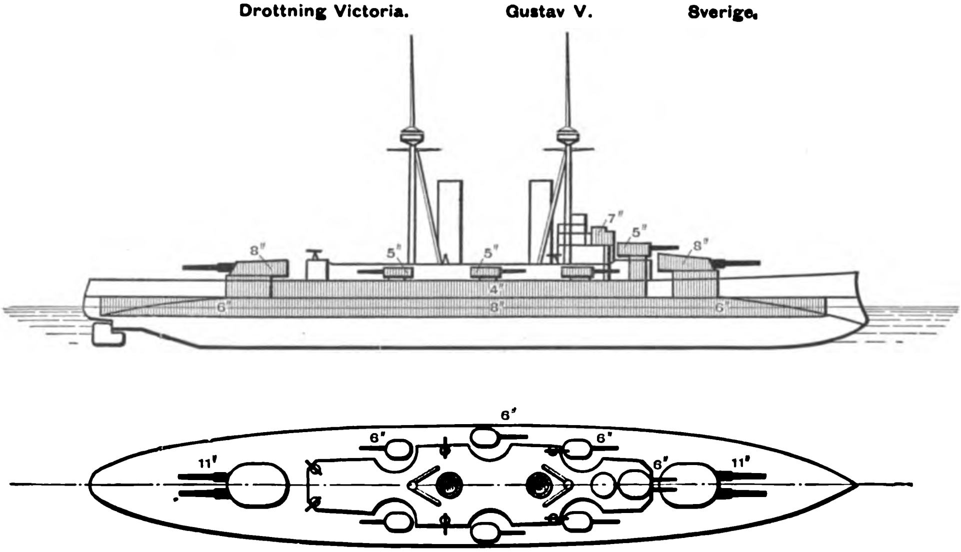
### Oscar II.




**Length, 313¾ ft. ; 4658 tons ; Speed, 18 knots ; Completed, 1907 ; Armament, 2—8·2 in., 8—6 in., 14 small.**

## ARMOURED CRUISER.

### Drottning Victoria. Gustav V. Sverige.

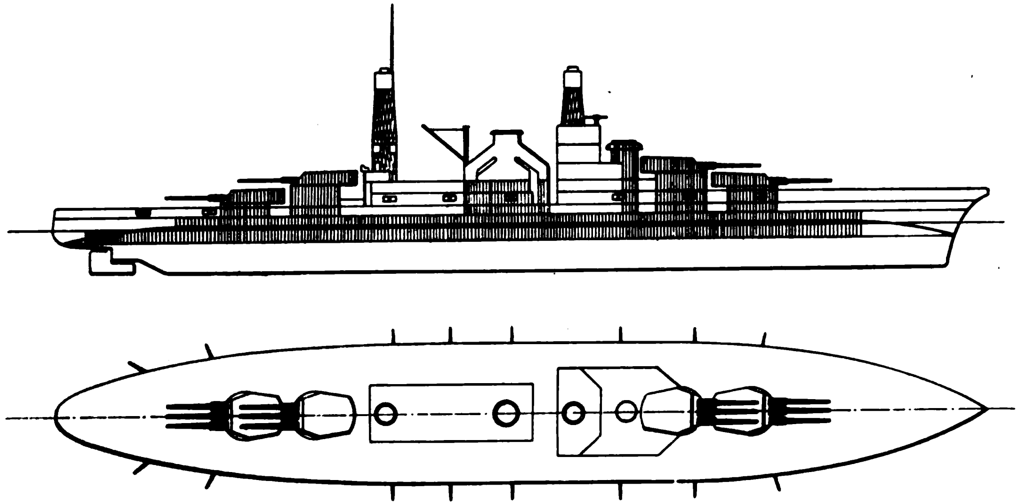



**Length, 390¼ ft. ; 7605 tons ; Speed, 22 knots to 24 knots ; Armament, 4—11 in., 8—6 in. ; 6—12 pr., 4 small.**

## UNITED STATES.

### BATTLESHIPS.

South Dakota. Indiana. Montana. North Carolina. Iowa. Massachusetts.

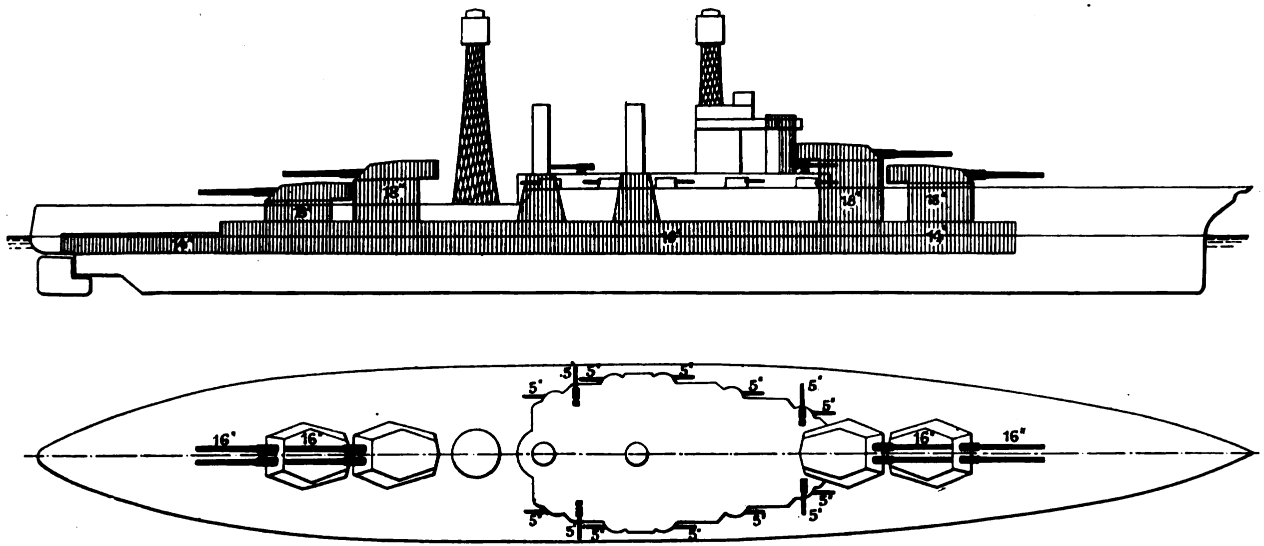


Length, 660 ft.; 43,200 tons; Speed, 23 knots; (Building);
Armament, 12—16 in., 16—6 in., 4—3 in. H.A.; Torpedo Tubes, 2—21 in. submerged

# UNITED STATES.

## BATTLESHIPS.

Colorado. Maryland. Washington. West Virginia.

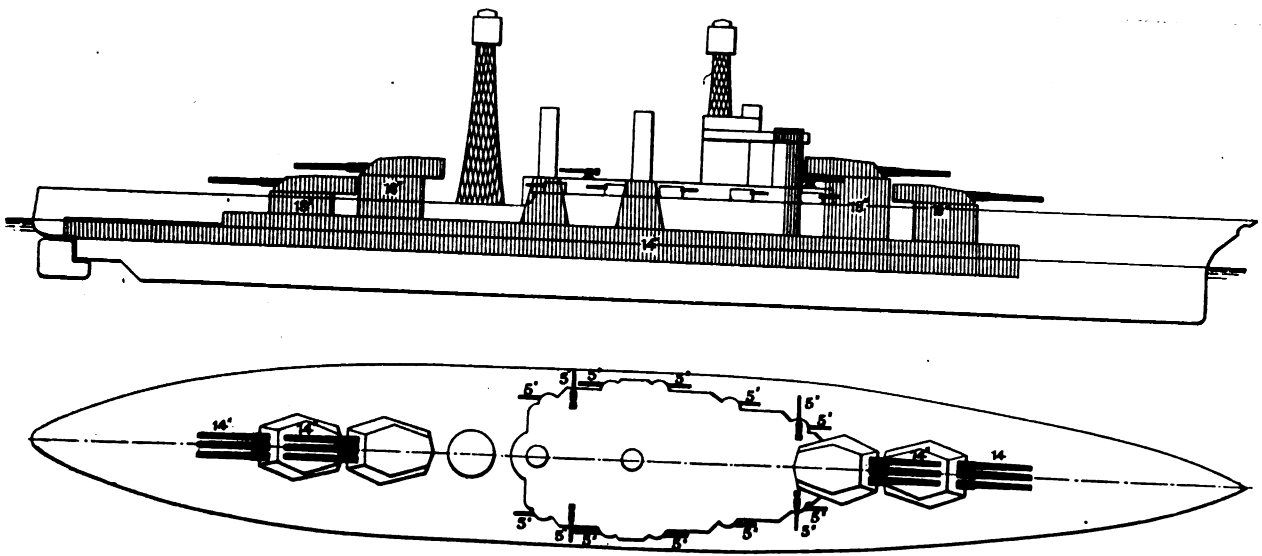



Length, 600 ft.; 32,600 tons; Speed, 21 knots;
Armament, 8—16 in., 14—5 in., 4—3 in. A.A., 4—6 pr.

## UNITED STATES.

### BATTLESHIPS.

California. Tennessee.

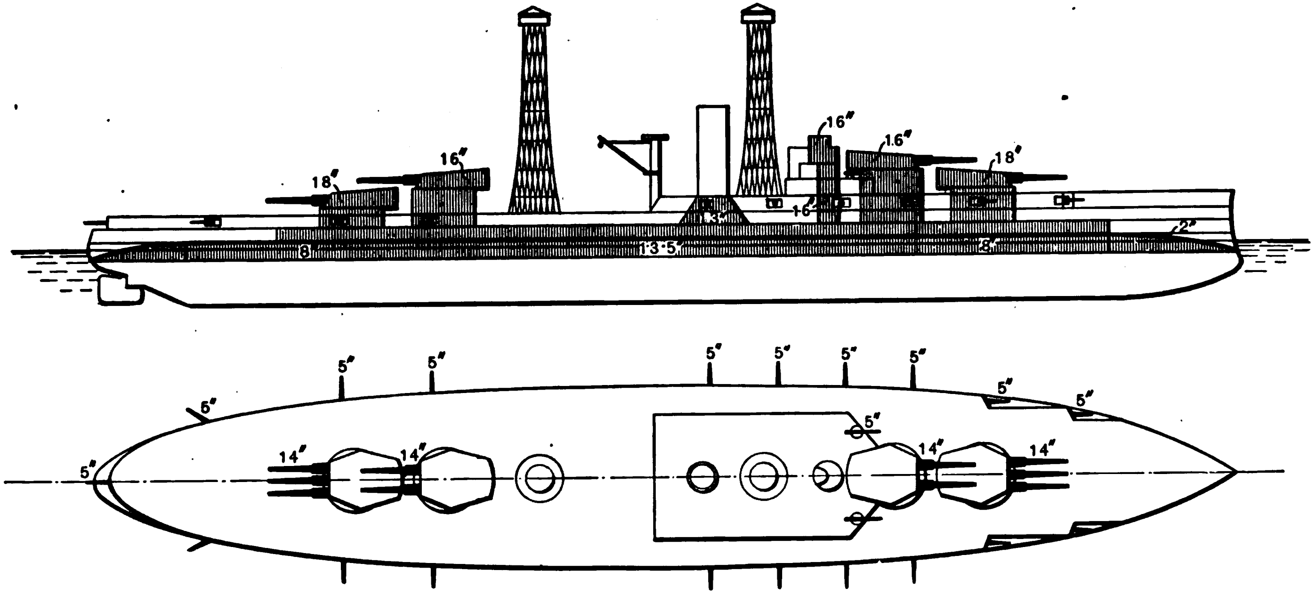


Length, 624 ft. and 600 ft.; 32,400 tons; Speed, 21 knots;
Armament, 12—14 in., 14—5 in., 4—3 in. A.A., 9 small.

# UNITED STATES.

## BATTLESHIPS.

Nevada. Oklahoma.

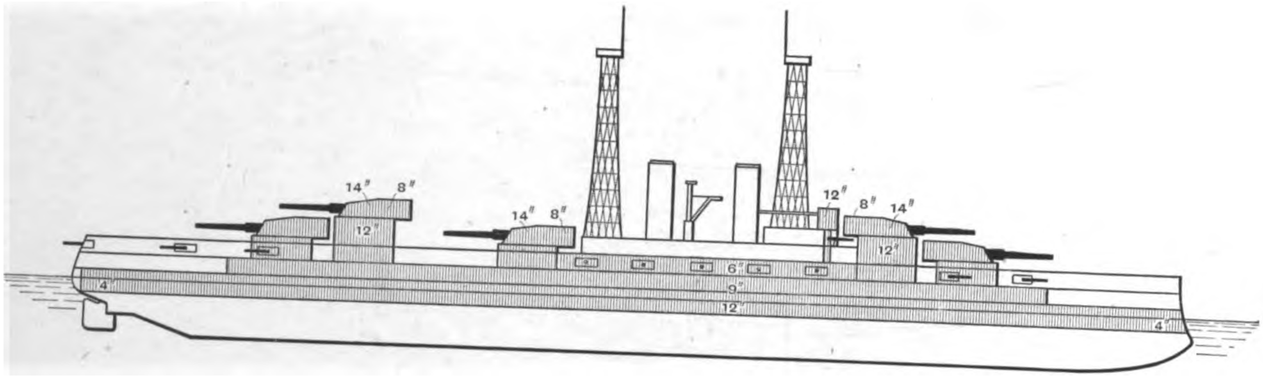


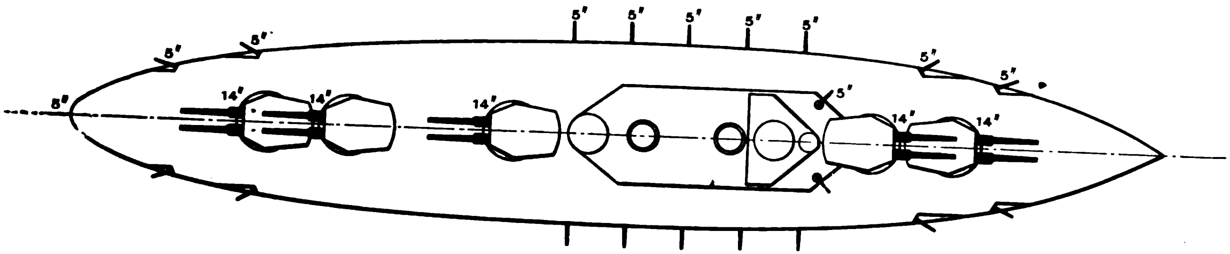

Length, 575 ft.; 27,500 tons; Speed, 20·5 knots; Completed, 1915;
Armament. 10—14 in.; there are now 12—5 in., 2—3 in. A.A., 22 small.

# UNITED STATES.

## BATTLESHIPS.

**New York.** **Texas.**



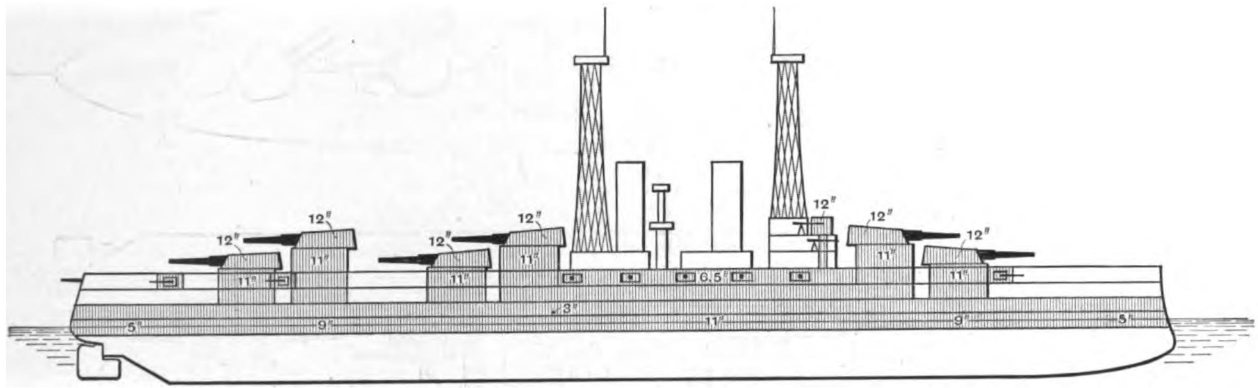



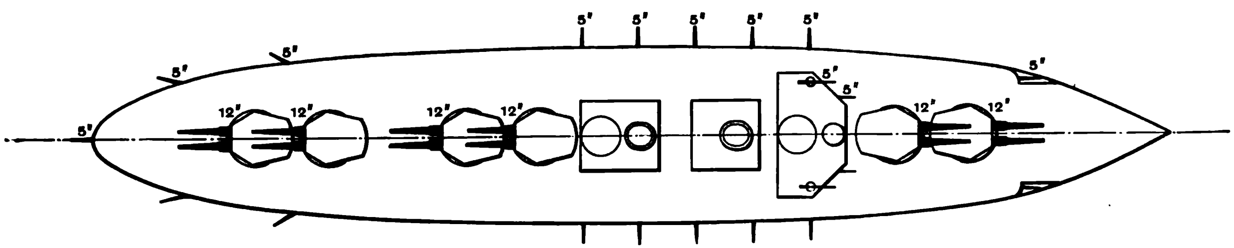

Length, 565 ft. ; 27,000 tons ; Speed, 21·5 and 21·1 knots ; Completed, 1914 ;
Armament, 10—14 in. The secondary armament has been changed; there are 16—5 in. and 2—3 in. A.A., 17 small.

UNITED STATES.

BATTLESHIPS.

**Arkansas.** **Wyoming.**



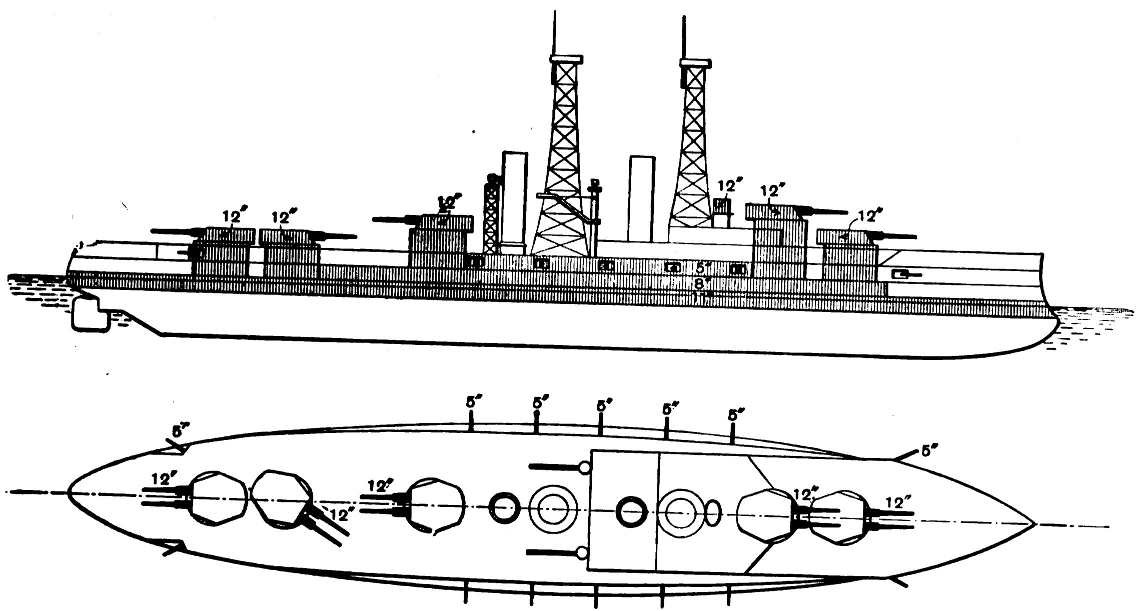




**Length, 554 ft.; 26,000 tons; Speed, 21 knots; Completed, 1912;**
**Armament: Arkansas, 12—12 in., 16—5 in., 2—3 in. A.A., 4—3 pr., and 5 smaller;**
**Wyoming, 12—12 in., 16—5 in., 4—3 in. A.A., 4—6 pr., 17 smaller.**

# UNITED STATES.

## BATTLESHIPS.

Delaware. North Dakota. Florida. Utah.

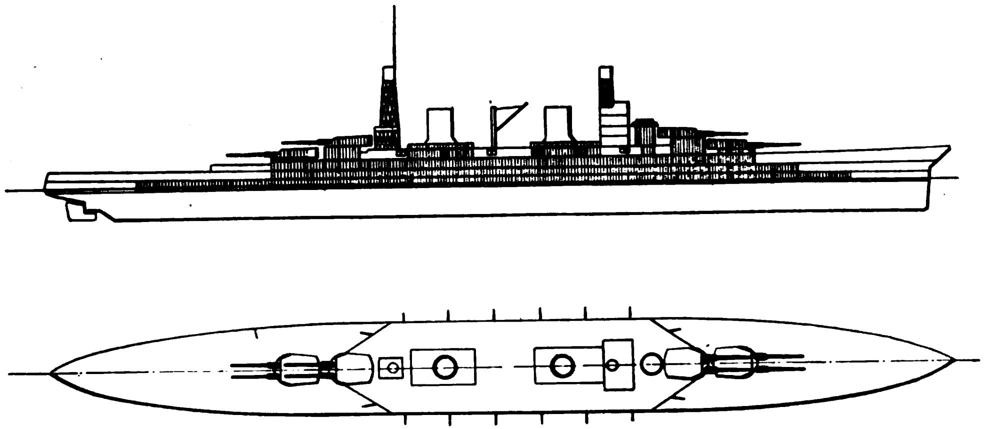



| | |
|---|---|
| Delaware<br>North Dakota | Length, 510 ft. ; 20,000 tons ; Speed, 21 knots ; Completed, 1910 ; Armament, 10—12 in., 14—5 in., 2—3 in. A.A., 16 smaller. |
| Florida<br>Utah | Length, 510 ft. ; 21,825 tons ; Speed, 22·1 knots and 21·6 knots ; Completed, 1911 ; Armament, 10—12 in., now 16—5 in., 4—3 in. A.A., and 6 smaller. |

# UNITED STATES.

## BATTLE CRUISERS.

**Lexington. Constellation. Saratoga. Ranger. Constitution. United States.**

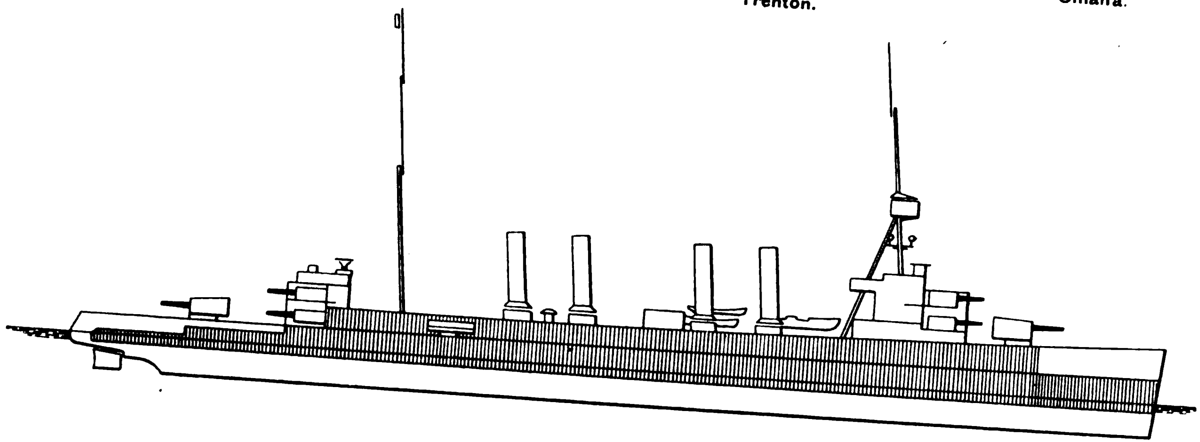


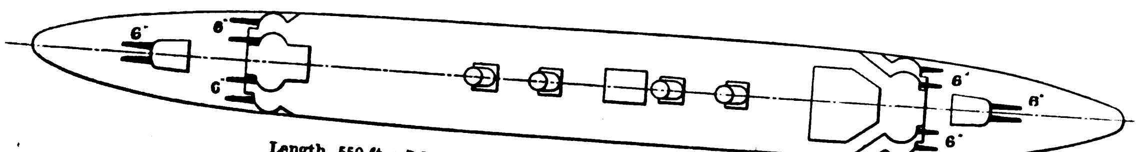
Length, 850 ft.; 43,500 tons; Speed, 33·33 knots; Building;
Armament, 8—16 in., 16—6 in., 4—3 in. A.A.; Torpedo Tubes, 8—21 in. (4 submerged).

## UNITED STATES.

### SCOUT CRUISERS.

Cincinnati. Concord. Detroit. Raleigh. Marblehead. Richmond. Memphis. Trenton. Milwaukee. Omaha.






Length, 550 ft. ; 7,500 tons ; Speed, 33·7 knots ; 1920, 1921, and Building.
Armament, 12—6 in., 2—14 pr. A.A., 2—3 pr.

# BRITISH AND FOREIGN ORDNANCE TABLES.

# VICKERS' GUNS AND MOUNTINGS.

**This Table is supplied by the Manufacturers.**

| | | 37 m/m Auto. | 37 m/m Auto. | 40 m/m Auto. | 3-pdr. Semi-Auto. | 6-pdr. Semi-Auto. | 3-in. Semi-Auto. | 4-in. Semi-Auto. | 4-in. Semi-Auto. | 4-in. B.L. | 4·7-in. B.L. | 4·7-in. B.L. | 4·7-in. Q.F. Naval Howitzer. | 5·118-in. B.L. | 6-in. B.L. | 6-in. B.L. | 6 in. Semi-Auto. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 cal. | 42·5 cal. | 40 cal. | 50 cal. | 50 cal. | 50 cal. | 40 cal. | 45 cal. | 50 cal. | 45 cal. | 48·5 cal. | 18 cal. | 54 cal. | 45 cal. | 50 cal. | 50 cal. |
| Construction . . . | ins. | S. | S. | S. | S. | S. | S. | S. & W. | S. & W. | S. & W. | S. & W. | S. | S. | S. | S. & W. | S. & W. | S. & W. |
| Diameter of Bore . . | ins. | 1·457 | 1·457 | 1·575 | 1·85 | 2·244 | 3 | 4 | 4 | 4 | 4·724 | 4·724 | 4·724 | 5·118 | 6 | 6 | 6 |
| Length of Bore . . | ins. | 43·5 | 62 | 62 | 92·5 | 112·2 | 150 | 160 | 180 | 201·15 | 212·6 | 228·45 | 85 | 276·37 | 269·5 | 300 | 300 |
| Length of Gun . . | ins. | 73·75 | 94 | 95·7 | 98·9 | 118·6 | 157 | 166·6 | 187·8 | 208·45 | 220 | 236·2 | 89·9 | 281·5 | 279·228 | 310·07 | 311·17 |
| | | lb. | lb. | lb. | cwt. | c. q. | cwt. | cwt. | cwt. | cwt. | t. c. | t. c. | c. q. | t. c. q. | t. c. q. | tons | t. c. |
| Weight of Gun . . . . | | 432 | 551 | 616 | 6 | 9 1 | 19 | 25 | 43 | 42 | 3 4 | 3 2 | 11 1½ | 5 3 2 | 7 8 2 | 8 | 8 19 |
| Weight of Projectile . . | lb. | 1 | 1·5 | 2 | 3·3 | 6 | 12·5 | 31 | 31 | 31 | 45 | 45·14 | 45 | 81·26 | 100 | 100 | 100 |
| Muzzle Velocity . . | f.s. | 1800 | 2100 | 2000 | 2800 | 2600 | 2700 | 2300 | 2700 | 3030 | 2800 | 3050 | 1200 | 2700 | 2900 | 3100 | 2900 |
| Nuzzle Energy . . | f.t. | 22·5 | 46 | 55·5 | 180 | 280 | 630 | 1135 | 1565 | 1975 | 2445 | 2910 | 450 | 4110 | 5830 | 6665 | 5830 |
| Penetration of Wrought Iron Plate at Muzzle, Gavre formula. Uncapped Projectiles | ins. | .. | .. | .. | 6·7 | 7·5 | 9·65 | 10·8 | 13·6 | 16 | 15·9 | 17·8 | .. | 20·8 | 22·6 | 24·8 | 22·6 |
| Rounds per minute . . . | | 200 | 200 | 200 | 30 | 28 | 25 | 20 | 18 | 15 | 12 | 12 | 10 | 10 | 10 | 10 | 8 |
| Weight of Mounting complete with Shield . . . | | lb. 800 | lb. 800 | lb. 1000 | c. q. lb. 11 2 5 | c. q. lb. 17 3 10 | t. c. q. lb. 1 3 1 10 | t. c. q. lb. 2 9 2 21 | t. c. q. 2 18 3 | t. c. q. lb. 3 5 0 27 | t. c. q. 3 15 0 | t. c. q. lb 5 9 1 21 | t. c. q. lb 4 1 2 11 | t. c. q. l. 12 9 3 13 | t. c. q. lb. 12 9 2 3 | t. c. q. 14 17 2 | t. c. q. lb. 12 0 1 24 |
| Weight of shield . . . | | .. | .. | .. | 1 0 20 | 1 2 10 | 2 0 14 | 7 2 0 | 7 2 | 14 1 13 | 15 2 | 1 12 2 0 | 2 0 0 4 | 4 4 3 16 | 4 4 3 16 | 6 5 0 | 5 5 1 15 |
| Thickness of Shield . | ins. | .. | .. | .. | ·22 | ·25 | ·25 | ·144 | ·144 | ·25 | ·25 | .3 | 1 9 | 1·5 & 1 | 1·5 & 1 | 4 to 1·2 | 3 to 1·2 |
| Angle of Elevation . | deg. | 80 | 80 | 80 | 20 | 20 | 20 | 30 | 30 | 30 | 30 | 30 | 70 | 30 | 30 | 30 | 15 |
| Angle of Depression . | deg. | 10 | 10 | 5 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 5 | 5 | 5 | 7 | 7 |

| | | 8-in. B.L. | 9·2-in. B.L. | 9·2-in. B.L. | 10-in. B.L. | 10-in. B.L. | 11-in. B.L. Naval Howitzer. | 12-in. B.L. | 12-in. B.L. | 13·5-in. B.L. | 14-in. B.L. | 14-in. B.L. | 15-in B.L. | 15-in. B.L. | 16-in. B.L. | 16-in. B.L. | 16-in. B.L. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 48·52 cal. | 45 cal. | 50 cal. | 45 cal. | 48·6 cal. | 8 cal. | 45 cal. | 50 cal. | 45 cal. | 45 cal. | 50·42 cal. | 40 cal. | 45 cal. | 40 cal. | 43·65 cal. | 45 cal. |
| Construction . . . . . | | S. | S. & W. | S. & W. | S. & W. | S. | S. | S. & W. | S. & W. | S. & W. | S. & W. | S. | S. & W. | S. & W. | S. & W. | S. | S. & W. |
| Diameter of Bore . . | ins. | 8 | 9·2 | 9·2 | 10 | 10 | 11 | 12 | 12 | 13·5 | 14 | 14 | 15 | 15 | 16 | 16 | 16 |
| Length of Bore . . | ins. | 388·2 | 414 | 461·4 | 450 | 486 | 88 | 540 | 600 | 607·5 | 630 | 705·88 | 600 | 675 | 640 | 698·45 | 720 |
| Length of Gun . . | ins. | 400 | 427·03 | 474·4 | 464·6 | 500 | 96·6 | 557·55 | 617·7 | 625·9 | 648·4 | 728 | 620·3 | 695·3 | 661·25 | 720 | 741·25 |
| | | t. c. q. | t. c. q. | t. c. q. | t. c. | t. c. | t. c. | t. c. | t. c. | t. c. q. | t. c. | tons | t. c. | tons | tons | t. c. | tons |
| Weight of Gun . . . . | | 14 3 1 | 26 11 3 | 28 6 2 | 34 17 | 27 17 | 1 18 | 57 14 | 66 14 | 76 12 1 | 83 9 | 82 | 82 10 | 97 | 100 | 107 14 | 117 |
| Weight of Projectile . . | lb. | 247·4 | 380 | 380 | 500 | 496·6 | 350 | 850 | 850 | 1400 | 1488 | 1648 | 1900 | 1900 | 2240 | 2461·2 | 2240 |
| Muzzle Velocity . . | f.s. | 3000 | 2800 | 2900 | 2780 | 2863 | 585 | 2850 | 3010 | 2500 | 2525 | 2700 | 2350 | 2500 | 2350 | 2500 | 2450 |
| Muzzle Energy . . | f.t. | 15440 | 20660 | 22160 | 26800 | 28225 | 682 | 47875 | 53400 | 60675 | 65790 | 83305 | 72750 | 82340 | 85780 | 106665 | 93230 |
| Penetration of Wrought Iron Plate at Muzzle. Gavre Formula. Uncapped Projectile . | ins. | 33·2 | 35·3 | 37 | 38·9 | 40·2 | — | 48·3 | 52·1 | 50 | 51·5 | 60·7 | 51 | 56 | 54 | 63 | 57 |
| Rounds per minute . . . | | 6 | 4 | 4 | 3 | 3 | 4 | 2 | 2 | 1·5 | 1·35 | 1·35 | 1·2 | 1·2 | 1·2 | 1·2 | 1·2 |

' Corrected to 1921

# VICKERS' GUNS AND MOUNTINGS.

## AIRCRAFT AND ANTI-AIRCRAFT GUNS.

| — | Aircraft. | | | | | | | | | Anti-Aircraft. | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ·303-in. Auto. | ·5-in. Auto. | 1-in. Auto. | 37 m/m. 1-pdr. Auto. | 40 m/m. 2-pdr. Auto. | 37 m/m. Semi-Auto. | 40 m/m. Q.F. | 40 m/m. Semi-Auto. | 6-pdr. Q.F. | 37 m/m. 1-pdr. Auto. | 37 m/m. 1·5-pdr. Auto. | 40 m/m. 2-pdr. Auto. | 3-pdr. Semi-Auto. | 3-in. Q.F. | 3·3-in. Q.F. | 4-in. Q.F. | 4-in. B.L. |
| | 93·7 cal. | 60 cal. | 30 cal. | 22 cal. | 42·5 cal. | 26·1 cal. | 25·1 cal. | 40 cal. | 25 cal. | 30 cal. | 42·5 cal. | 40 cal. | 50 cal. | 45 cal. | 50 cal. | 45 cal. | 50 cal. |
| Construction | S. | S. | S. | S. | S. | S. | S. | S. | S. | S. | S. | S. | S. | S. & W. | S. & W. | S. & W. | S. & W. |
| Diameter of Bore . . ins. | ·303 | ·5 | 1 | 1·457 | 1·575 | 1·457 | 1·575 | 1·575 | 2·244 | 1·457 | 1·457 | 1·575 | 1·85 | 3 | 3·3 | 4 | 4 |
| Length of Bore . . ,, | 28·4 | 30 | 30 | 32·05 | 62 | 38·06 | 39·56 | 63 | 56·1 | 43·5 | 62 | 62 | 92·5 | 135 | 165 | 180 | 200 |
| Length of Gun . . ,, | 41·3 | 46·5 | 55 | 59·7 | 108 | 40·25 | 41·75 | 65·25 | 59·5 | 73·75 | 94 | 95·7 | 98·9 | 140·25 | 170·3 | 187·8 | 208·45 |
| | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | cwt. | c. q. | t. c. q. | t. c. | t. c. q. |
| Weight of Gun | 30 | 50 | 110 | 130 | 400 | 110 | 132 | 234 | 284 | 432 | 551 | 616 | 6 | 18 3 | 1 13 2 | 1 18 | 2 1 3 |
| Weight of Projectile . lb. | 174 grs. | 570 grs. | ·441 | 1 | 2 | 1·5 | 2 | 2 | 6 | 1 | 1·5 | 2 | 3·3 | 12·5 | 21 | 31 | 31 |
| Muzzle Velocity . . f.s. | 2400 | 2600 | 1542 | 1200 | 2000 | 1200 | 1200 | 2300 | 1200 | 1800 | 2100 | 2000 | 2800 | 2600 | 2400 | 2700 | 3030 |
| Muzzle Energy . . f.t. | 1 | 3·8 | 7·25 | 10 | 55·5 | 15 | 20 | 73 | 60 | 22·5 | 46 | 55·5 | 180 | 585 | 810 | 1565 | 1975 |
| Rounds per minute | 500 to 1000 | 300 to 1000 | 200 | 150 | 100 | — | — | — | — | 200 | 200 | 200 | 30 | 25 | 20 | 18 | 15 |
| | | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | c. q. l. | t. c. q. l. | t. c. q. l. | | t. c. q. l. |
| Weight of Mounting | — | 25 | 65 | 100 | 140 | 333 | 130 | 432 | 185 | 800 | 800 | 1000 | 18 2 3 | 2 8 3 0 | 4 8 2 23 | — | 3 7 2 0 |
| Angle of Elevation . deg. | — | 80 | 40 | 60 | 72 | 30 | 70 | 60 | 60 | 80 | 80 | 80 | 80 | 85 | 85 | — | 80 |
| Angle of Depression . ,, | — | 30 | 90 | 60 | 30 | 30 | 40 | 30 | 90 | 10 | 10 | 5 | 5 | 10 | 0 | — | 5 |

## HOWITZERS, FIELD, MOUNTAIN AND LANDING GUNS.

| | Howitzers. | | | | Field. | | | | | Mountain. | | Landing. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6-in. B.L. | 8-in. B.L. | 9·2-in. B.L. | 12-in. B.L. | 3-in. Q.F. | 3-in. Q.F. | 3·3-in. Q.F. | 5-in. B.L. | 6-in. B.L. | 75-mm. Q.F. | 3-in. Q.F. | 3-in. Q.F. |
| | 21 cal. | 17·3 cal. | 17·3 cal. | 17·3 cal. | 22·9 cal. | 33·2 cal. | 28·1 cal. | 37 cal. | 35 cal. | 17 cal. | 14·3 cal. | 22 cal. |
| Construction | S. & W. | S. & W. | S. & W. | S. & W. | S. & W. | S. | S. & W. | S. & W. | S. & W. | S. | S. | S. |
| Diameter of Bore . ins. | 6 | 8 | 9·2 | 12 | 3 | 3 | 3·3 | 5 | 6 | 2·953 | 3 | 3 |
| Length of Bore . ins. | 126 | 138·4 | 159·16 | 207·6 | 68·7 | 99·5 | 92·735 | 185 | 210 | 50·2 | 42·94 | 66 |
| Length of Gun . ins. | 131·15 | 148·3 | 170·51 | 222·35 | 73·26 | 103·8 | 96·96 | 192·25 | 219·22 | 53·85 | 47·28 | 70·34 |
| | t. c. q. | t. c. | t. c. q. | t. c. q. | c. q. | c. q. | c. q. | t. c. q. | t. c. q. | c. q. l. | c. q. l. | c. q. l. |
| Weight of Gun | 1 19 2 | 3 7 | 4 5 2 | 9 2 2 | 6 0 | 7 2 | 8 2 | 2 3 1 | 4 11 2 | 3 3 10 | 2 2 4 | 3 3 4 |
| Weight of Projectile lb. | 86 | 200 | 290 | 750 | 15 | 14·33 | 18·5 | 60 | 100 | 14·33 | 12·5 | 12·5 |
| Muzzle Velocity . f.s. | 1760 | 1520 | 1520 | 1520 | 1480 | 1660 | 1650 | 2200 | 2400 | 1312 | 1150 | 1640 |
| Muzzle Energy . f.t. | 1845 | 3205 | 4645 | 12015 | 228 | 274 | 350 | 2015 | 3995 | 171 | 115 | 233 |
| Rounds per minute | 3 | 2 | 2 | 1 | 25 | 25 | 20 | 4 | 3 | 15 | 15 | 25 |
| | t. c. q. | t. c | t. c. | t. c. | c. q. l. | c. q. l. | c. q. l. | t. c. q. | t. c. q. | c. q. l. | c. q. l. | c. q. l. |
| Weight of Mounting complete with Shield | 2 16 2 | 5 14 | 11 5 | 36 10 | 14 2 14 | 14 0 0 | 19 2 0 | 2 17 0 | 5 12 0 | 10 1 0 | 7 1 0 | 9 2 0 |
| Weight of Shield | — | — | — | — | 1 2 0 | 1 0 15 | 1 3 0 | — | — | 1 1 0 | 2 17 | 1 1 15 |
| Thickness of Shield ins. | — | — | — | — | ·125 | ·144 | ·125 | — | — | ·125 | ·125 | ·192 |
| Angle of Elevation deg. | 42 | 45 | 50 | 65 | 30 | 16 | 37·5 | 42 | 38 | 50 | 25 | 23 |
| Angle of Depression deg. | 0 | 0 | 0 | 0 | 5 | 10 | 5 | 0 | 0 | 10 | 15 | 10 |

Corrected to 1921.

# ELSWICK B.L. AND Q.F. GUNS.

## This Table is supplied by the Manufacturers.

| | Automatic for Aircraft. | | | | Semi-Automatic. | | | Semi-Auto-matic. | Non-recoil. | | Naval Land-ing. | Anti-Air-craft. | Anti-Air-craft. | Semi-Auto-matic | Jointed Gun. | | Semi-Auto-matic. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Bore .........ins. | 1·457 | 1·457 | 0·9 | 1·85 | 1·85 | 1·85 | 2·24 | 2·24 | 2·24 | 2·953 | 3 | 3* | 3 | 3 | 3 | 4 | 4 | 4·7 | 4·7 |
| do. do. .........mm. | 37 | 37 | 22·86 | 47 | 47 | 47 | 57 | 57 | 57 | 75 | 76 | 76 | 76 | 76 | 76 | 102 | 102 | 120 | 120 |
| Length of Bore .........cals. | 45 | 40 | 66 | 40 | 46 | 50 | 40 | 50 | 27 | 14·13 | 18·8 | 28 | 50 | 50 | 19·2 | 50 | 40 | 45 | 50 |
| | lb. | lb. | lb. | cwts. | cwts. | cwts. | cwts. | cwts. | lb. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. | cwts. |
| Weight of Gun .................. | 340 | 230 | 230 | 4·51 | 5·0 | 7·5 | 7 5 | 10·5 | 329 | 1·875 | 4 | 8 | 19 | 23 | 4·5 | 42 | 27 | 53 | 66 |
| do. do. .........kilos. | 154 | 104 | 104 | 230 | 254 | 381 | 381 | 533 | 149 | 95 | 203 | 406 | 978 | 1168 | 229 | 2134 | 1360 | 2692 | 3353 |
| do. Projectile .........lbs. | 1·5 | 1·5 | 6 oz. | 3·3 | 3·3 | 3·3 | 6 | 6 | 6 | 11·75 | 12·5 | 12·5 | 12·5 | 14·33 | 14·33 | 31 | 31 | 45 | 45 |
| do. do. ......kilos. | 0·681 | 0·681 | 0·17 | 1·5 | 1·5 | 1·5 | 2·722 | 2·722 | 2·72 | 5·33 | 5·67 | 5·67 | 5·67 | 6·5 | 6·5 | 14·06 | 14 06 | 20·41 | 20·41 |
| | oz. | oz. | oz. | oz. | oz. | lb. oz. | oz. | lb. oz. | oz | oz. | oz. | lb. | lb. oz. | lb. | ozs. | lb. | lb. | lb. oz. | lb. |
| do. Charge, M.D. Cordite | 2¼ | 2¼ | 1¼ | 8·25 | 10·0 | 1 0 | 10 | 1 2 5 | 7¾ | 7·75 | 15 | 1·1 | 3 2¼ | 5·75 | 15 | 10·5 | 5·0 | 9 11 | 14 |
| do. do. do. kilos. | 0·071 | 0·071 | 0·042 | 0·234 | 0·283 | 0·453 | 0·283 | 0·525 | 0·22 | 0·22 | 0·369 | 0·5 | 1·43 | 2·608 | 0·425 | 4·76 | 2·27 | 4·395 | 6·35 |
| Muzzle Velocity .........f.s. | 2035 | 2000 | 2800 | 2132 | 2300 | 2680 | 1968 | 2400 | 1000 | 1100 | 1585 | 1640 | 2700 | 3050 | 1485 | 3000 | 2300 | 2600 | 3000 |
| do. do. ......m.s. | 620 | 609 | 853 | 650 | 701 | 817 | 600 | 731 | 305 | 335 | 483 | 500 | 823 | 930 | 452 | 914 | 701 | 792 | 914 |
| Muzzle Energy .........f.t. | 43 | 41·6 | 20·4 | 104 | 121 | 164 | 161 | 240 | 41·6 | 98 | 213 | 233 | 632 | 923 | 218 | 1934 | 1137 | 2109 | 2808 |
| do. do. .........m.t. | 13·3 | 12·8 | 6·3 | 32·2 | 37 5 | 50·8 | 49·8 | 74·3 | 12·8 | 30·3 | 66 | 72 | 196 | 285·5 | 67·5 | 599 | 352 | 653 | 869·6 |
| Penetration at Muzzle ...ins. (Tressider Wrought Iron Pl.) | 3·5 | 3·4 | 3·6 | 5·15 | 5·8 | 7·3 | 5·4 | 7·3 | 1·95 | .. | .. | 5·1 | 10·8 | 13 7 | .. | 17·4 | 11·6 | 15·6 | 19·3 |
| do. do. ...mm. | 88·9 | 86·3 | 91·4 | 130·8 | 147·3 | 185·4 | 137·2 | 185·4 | 49·5 | .. | .. | 129·5 | 274 | 348·0 | .. | 442·0 | 294·6 | 396·2 | 490·2 |
| Rounds per Minute............ | 70 | 70 | 80 | 25 | 30 | 30 | 25 | 30 | .. | 20 | 20 | 20 | 20 | 25 | 15 | 12 | 20 | 12 | 12 |

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Bore .........ins. | 5 | 5·5 | 6 | 6 | 7·5 | 7·5 | 8 | 8 | 9·2 | 9·2 | 10 | 10 | 12† | 12† | 13·5 | 14† | 15 | 15 | 16 | 18 |
| do. do. .........mm. | 127·2 | 139·7 | 152 | 152 | 190 | 190 | 203 | 203 | 234 | 234 | 254 | 254 | 305 | 305 | 343 | 355·6 | 381 | 381 | 406 | 457 |
| Length of Bore .........cals. | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 45 | 40 | 45 | 45 | 40 |
| | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons | tons |
| Weight of Gun .................. | 4·05 | 5·65 | 8·4 | 8·75 | 13·8 | 15 75 | 18·0 | 20·4 | 26·75 | 28·82 | 36·25 | 38·25 | 59·3 | 66·7 | 76 | 85 | 85 | 98·6 | 108 | 152 |
| do. do. .........kilos. | 4114 | 5740 | 8535 | 8890 | 14021 | 16003 | 18289 | 20727 | 27179 | 29289 | 36832 | 38864 | 60252 | 67770 | 77216 | 86364 | 86364 | 96118 | 109728 | 154440 |
| do. Projectile .........lbs. | 60 | 83 | 100 | 100 | 200 | 200 | 250 | 250 | 380 | 380 | 500 | 500 | 850 | 850 | 1250 | 1400 | 1920 | 1925 | 2130 | 3320 |
| do. do. ......kilos. | 27·2 | 37·6 | 45·36 | 45 36 | 90·72 | 90·72 | 113·4 | 113·4 | 172·37 | 172·37 | 226·8 | 226·8 | 385·55 | 385·55 | 567 | 635 | 871 | 873·2 | 966 | 1506 |
| | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. |
| do. Charge, M.D. Cordite | 16 | 25·0 | 31 | 33·0 | 74 | 76 | 80 | 90 | 122 | 136 | 167 | 200 | 260 | 285 | 296 | 324 | 380 | 400 | 580 | 690 |
| do. do. do. kilos. | 7·25 | 11·34 | 14·061 | 15·0 | 33·566 | 34·473 | 36·29 | 40·82 | 55·34 | 61·7 | 75·75 | 90·72 | 117·93 | 129·3 | 134·26 | 147 | 172·3 | 181 | 263 | 313 |
| Muzzle Velocity ............f.s. | 2700 | 2900 | 2800 | 3000 | 2900 | 3000 | 2845 | 3000 | 2750 | 3000 | 2800 | 3000 | 2800 | 3000 | 2700 | 2700 | 2362 | 2500 | 2630 | 2400 |
| do. do. .........m.s. | 823 | 884 | 853 | 914 | 884 | 914 | 867 | 914 | 838 | 914 | 853 | 914 | 853 | 914 | 823 | 823 | 720 | 762 | 801·6 | 731 |
| Muzzle Energy ............f.t. | 3032 | 4840 | 5436 | 6240 | 11663 | 12481 | 14031 | 15600 | 19926 | 23714 | 27181 | 31203 | 46208 | 53046 | 63187 | 70770 | 74275 | 83425 | 102160 | 132600 |
| do. do. .........m.t. | 939 | 1499 | 1683·4 | 1932 | 3611·9 | 3865·2 | 4345·2 | 4831·2 | 6171 | 7340 | 8418 | 9663 | 14310 | 16428 | 19568 | 21916 | 23002 | 25835 | 31670 | 41065 |
| Penetration at Muzzle ...ins. (Tressider Wrought Iron Pl.) | 18·4 | 25·8 | 22·9 | 25·5 | 30·6 | 32·3 | 32·2 | 34·9 | 35·2 | 40·1 | 39·7 | 44·1 | 47·3 | 52·5 | 51·3 | 53·2 | 49·1 | 53·7 | 58 | 60 |
| do. do. ...mm. | 724 | 701·0 | 581·6 | 647·7 | 777·2 | 820·4 | 817·9 | 886·4 | 894·1 | 1018·5 | 1008·4 | 1120·1 | 1201·4 | 1333·5 | 1363·0 | 1351·3 | 1247 | 1364 | 1473 | 1524 |
| Rounds per Minute............ | 10 | 10 | 9 | 9 | 6 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

Corrected to 1921.

* This gun can be arranged for anti-torpedo boat attack also.
† These guns can be used on Railway Truck Mountings.

# ELSWICK HOWITZER, FIELD AND TRENCH GUNS.

**This Table is supplied by the Manufacturers.**

| | Mountain Gun. | Field. | Horse and Field. | Field. | | | Howitzers. | | | | Field Position. | Howitzers. | | | | | | Bomb Thrower | Trench Howtzr. | Trench Howtzr. | Stick Bomb Thrower | Anti-Aircraft. | Tank. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Diameter of Bore ... ins. | 2·953 | 3 | 3 | 3·3 | 3·3 | 4 | 3·75 | 4·5 | 4 | 4·7 | 5 | 6 | 8 | 9·2 | 11 | 11·24 | 12 | 13·5 | 11 | 5 | 3·5 | 3 | 2·244 |
| ,, ,, ... mm. | 75 | 76 | 76 | 84 | 84 | 101·6 | 95·25 | 114·2 | 102 | 120 | 127 | 152 | 203 | 234 | 279·4 | 285·5 | 304·8 | 342·9 | 279·4 | 127 | 88·9 | 76·2 | 57 |
| Length of Bore ... calibres | 16·2 | 28 | 23 | 28 | 33 | 30 | 23 | 20 | 8·75 | 12 | 32 | 12·2 | 17 | 13·7 | 12 | 15 | 17.3 | .. | 5 | 5·4 | .. | 45 | 23 |
| | lb. | cwt. | cwt. | cwt. | cwt. | tons | cwt. | cwt. | lb. | cwt. | tons | ton | tons | tons | tons | tons | tons. | lb. | lb. | lb. | lb. | cwt. | cwt. |
| Weight of Gun ... ... ... | 260 | 7·25 | 6 | 9 | 9½ | 1·09 | 11·25 | 14·75 | 220 | 8 | 2 | 1 | 2·9 | 4·3 | 5·5 | 7·85 | 10·5 | 973 | 1481 | 252 | 863 | 20 | 5 |
| ,, ,, ... kilos | 118 | 368 | 305 | 457 | 483 | 1112 | 571 | 749 | 100 | 406 | 2032 | 1016 | 2950 | 4369 | 5588 | 7976 | 10,668 | 441 | 672 | 114 | 391 | 1016 | 254 |
| ,, Projectile lbs. | 12·5 | 14·3 | 12·5 | 18·5 | 20½ | 31 | 27·5 | 35 | 20 | 35 | 60 | 100 | 220 | 290 | 500 | 661·38 | 760 | 200 | 200 | 40 | 200 | 12·5 | 6 |
| ,, ,, kilos. | 5·67 | 6·49 | 5·67 | 8·39 | 9·3 | 14 | 12·5 | 15·87 | 9·07 | 15·87 | 27·22 | 45·36 | 100 | 131·5 | 227 | 300 | 340·2 | 90·7 | 90·7 | 18 | 90·7 | 5·6 | 2·722 |
| | oz. | oz. | lb. oz. | lb. oz. | lb. oz. | lb. | lb. oz. | lb. oz. | oz. | lb. oz. | lb. oz. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | lb. | oz. | lb. oz. | lb. oz. | oz. |
| ,, Charge M.D. Cordite | 10 | 20¼ | 1 4 | 1 6 | 1 9 | 4·75 | 2 5¼ | 1 7 | 8¼ | 1 4¼ | 9 8 | 3 | 19·5 | 14 | 20 | 32 | 49 | 1¼ | 1 | 3½ | 2 10 | 2 10 | 8¾ |
| ,, ,, ,, kilos. | 0·283 | 0·582 | 0·567 | 0·624 | 0·71 | 2·15 | 1·066 | 0·652 | 0·241 | 0·582 | 4·31 | 1·361 | 8·85 | 6·35 | 9·07 | 14·51 | 22·2 | ·6 | 454 | ·1 | 1·2 | 1·2 | ·248 |
| Muzzle Velocity ... ... f.s. | 1250 | 1755 | 1700 | 1635 | 1750 | 2000 | 1550 | 1450 | 950 | 1150 | 2150 | 1000 | 1560 | 1250 | 1220 | 1230 | 1470 | 380 | 400 | 429 | 355 | 2575 | 1580 |
| ,, ,, ... m.s. | 381 | 535 | 518 | 498 | 533 | 610 | 477·4 | 442 | 290 | 350 | 655 | 305 | 472·5 | 381 | 372 | 375 | 448 | 115·8 | 122 | 130·7 | 108·2 | 784·8 | 481·5 |
| Muzzle Energy ............f.t. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 11,238 | 200 | 222 | 51 | 174·7 | 574·7 | 103·9 |
| do. do. ...........m.t. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 3480 | 61·9 | 68·7 | 15·8 | 54·1 | 178 | 32·2 |
| Penetration at Muzzle ...ins. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 16·9 | .. | .. | .. | .. | 10·1 | 3·9 |
| (Tessider Wrought Iron Pl.) do. do. mm. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 429·2 | .. | .. | .. | .. | 256·5 | 99 |
| Rounds per Minute............ | .. | .. | .. | .. | 20 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 2 | .. | .. | .. | .. | 20 | 25 |

Corrected to 1921

# BEARDMORE GUNS.

**This Table is supplied by the Manufacturers.**

(August, 1921.)

| Gun Calibre. | Length of Bore. | Weight of Gun. | | Weight of Shot. | Muzzle Velocity. |
|---|---|---|---|---|---|
| inches. | calibres. | tons. | cwts. | lbs. | ft.-secs. |
| 16·0 | 45·0 | 107 | 0 | 2350 | 2520 |
| 15·0 | 45·0 | 96 | 0 | 1850 | 2600 |
| 13·5 | 46·0 | 77 | 0 | 1875 | 2620 |
| 12·0 | 50·0 | 66 | 0 | 950 | 2820 |
| 9·2 | 50·0 | 28 | 10 | 425 | 2810 |
| 7·5 | 45·0 | 13 | 18 | 200 | 2800 |
| 6·0 | 50·0 | 8 | 14 | 100 | 2950 |
| 6·0 | 45·0 | 6 | 18 | 100 | 2800 |
| 5·5 | 45·0 | 5 | 16 | 82 | 2650 |
| 5·0 | 50·0 | 4 | 6 | 60 | 2950 |
| 4·7 | 45·0 | 3 | 4 | 45 | 2750 |
| 4·0 | 50·0 | 2 | 3 | 31 | 3000 |
| 4·0 | 45·0 | 2 | 2 | 31 | 2800 |
| 3·3 | 29·5 | 0 | 9 | 185 | 1700 |
| 3·0 | 40·0 | 0 | 12 | 125 | 2250 |
| 2·24 | 23·2 | 0 | 5 | 6 | 1525 |

# FRENCH NAVAL ORDNANCE.

| Date and Pattern of Gun. | Model 1913. | Model 1906. | Model 1902. | Model 1893–96. | | | | Model 1893. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Desig. by Calibre, in cms. | 34 | 30·5 | 30·5 | 30·5 | 27·44 | 24·0 | 19·4 | 34·0 | 30·5 | 27·44 | 24·0 | 19·4 |
| Calibre, in inches | 13·4 | 12·01 | 12·01 | 12·01 | 10·8 | 9·45 | 7·64 | 13·39 | 12·0 | 10·8 | 9·45 | 7·64 |
| Total length, in feet | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Length of Bore, in ins. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Length of Bore, in cals. | 45 | 50 | 45 | 40 | 40 | 45 | 45 | 35 | 40 | 40 | 40 | 40 |
| Total weight, in tons | 66 | 45 | .. | 44·4 | 34·5 | 23·6 | 12·5 | 52·9 | 45·9 | 34·9 | 22·4 | 10·6 |
| Weight of Firing Charge, Armour-piercing Projectile . lb. | .. | .. | .. | 246 | 188·5 | 145½ | 74 | 243·0 | 198·4 | 114·6 | 110·2 | 44·1 |
| Weight { Armour-piercing Projectile . lb. | 1190 | 969 | 750 | 750 | 562 | 375 | 190 | 925·9 | 643·8 | 476·2 | 317·5 | 165·3 |
| Weight { Common Shell . „ | .. | .. | .. | 750 | 562 | 375 | 190 | 925·9 | 643·8 | 476·2 | 317·5 | 165·3 |
| Muzzle Velocity, in f.-s., A.P. Projectile | .. | 2871 | 2870 | 2650 | 2650 | 2870 | 2870 | 2400 | 2625 | 2625 | 2625 | 2625 |
| Muzzle Energy { Total, in f.-t. | 65340 | 54343 | 42890 | 36782 | 27186 | 21445 | 10890 | 36850 | 30750 | 22750 | 15170 | 7898 |
| Muzzle Energy { Per in. circ., f.-t. | .. | .. | .. | .. | .. | .. | .. | .. | 815·8 | 670·7 | 511·1 | 329·1 |
| Perforation at Muzzle,† wrought iron, inches | .. | .. | 46·0 | 42·7 | 38·8 | 37·0 | 29·0 | 36·8 | 37·3 | 33·7 | 29·4 | 23·4 |
| Perforation Krupp Steel, 3000 yds. | 11·8 (9000 mètres) | .. | 15½ | 13½ | 11½ | 10½ | 6¾ | 11½ | 11 | 9 | 7½ | 5½ |

Corrected to 1920.

† By Tresidder's formula.

In the cruisers intended to be laid down in 1921–22 a 19·4 cm. gun of a new pattern is to be mounted.

# UNITED STATES NAVAL ORDNANCE.

| GUN. | MARK. | Length in Calibres. | Total Length. | Capacity of Chamber in Cubic Inches. | Travel of Projectile in Inches. | Weight of Gun. | Weight of Projectile. | Weight of Charge. | Muzzle Velocity. | Muzzle Energy. | Penetration at Muzzle, Krupp Armour, using Capped Projectile. | At 3000 Yards. Remaining Velocity. | At 3000 Yards. Penetration. | At 6000 Yards. Remaining Velocity. | At 6000 Yards. Penetration. | At 9000 Yards. Remaining Velocity. | At 9000 Yards. Penetration. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | inch. | | | tons. | lb. | lb. | ft.-seconds. | ft.-tons. | inch. | ft.-seconds. | inch. | ft.-seconds. | inch. | ft.-seconds. | inch. |
| 3-in. R.F.G. | II., III. | 50 | 154 | 219 | 128·3 | 0·9 | 13 | 3·85 | 2700 | 658 | 3·3 | 1230 | 1·2 | 848 | 0·8 | .. | .. |
| 3-in. S.A. | V., VI.† | 50 | 159 | 219 | 128·3 | 1·0 | 13 | 3·85 | 2700 | 658 | 3·3 | 1230 | 1·2 | 848 | 0·8 | .. | .. |
| 4-in. R.F.G. | III., IV., V., VI. | 40 | 164 | 331 | 134·5 | 1·5 | 33 | 4·85 | 2000 | 915 | 3·4 | 1156 | 1·7 | 897 | 1·2 | .. | .. |
| 4-in. R.F.G. | VII. | 50 | 205 | 652 | 168·3 | 2·6 | 33 | 9·0 | 2500 | 1,430 | 4·6 | 1432 | 2·2 | 979 | 1·4 | 853 | 1·2 |
| 4-in. R.F.G. | VIII.‡ | 50 | 205 | 652 | 168·3 | 2·9 | 33 | 12·3 | 2800 | 1,794 | 5·3 | 1627 | 2·6 | 1033 | 1·5 | 878 | 1·2 |
| 5-in. R.F.G. | II., III., IV. | 40 | 206 | 656 | 165·8 | 3·1 | 50 | 10·0 | 2300 | 1,852 | 5·3 | 1286 | 2·6 | 934 | 1·7 | 829 | 1·4 |
| 5-in. B.L.R. | V., VI. | 50 | 256 | 1,200 | 215·6 | 4·6 | 60 | 19·2 | 2700 | 3,032 | 6·2 | 1692 | 3·5 | 1102 | 2·0 | 928 | 1·6 |
| 5-in. B.L.R. | VI. | 50 | 256 | 1,200 | 215·6 | 4·6 | 50[1] | 20·5 | 3000 | 3,122 | 6·4 | 1732 | 3·2 | 1057 | 1·7 | 877 | 1·4 |
| 5-in. R.F.G. | VII.§ | 51 | 261 | 1,135 | 215·6 | 5·0 | 50 | 23·8 | 3150 | 3,439 | 6·8 | 1835 | 3·4 | 1091 | 1·8 | 895 | 1·4 |
| 6-in. R.F.G. | II., III. | 30 | 196 | 1,287 | 150·0 | 4·8 | 105 | 18·8 | 1950 | 2,768 | 5·3 | 1305 | 3·2 | 1009 | 2·3 | 909 | 2·0 |
| 6-in. R.F.G. | IV., VII. | 40 | 256 | 1,320 | 205·8 | 6·0 | 105 | 18·8 | 2150 | 3,365 | 6·0 | 1440 | 3·6 | 1058 | 2·4 | 934 | 2·1 |
| 6-in. R.F.G. | IX. | 45 | 270 | 1,320 | 221·7 | 7·0 | 105 | 18·8 | 2250 | 3,685 | 6·3 | 1511 | 3·8 | 1086 | 2·5 | 948 | 2·1 |
| 6-in. B.L.R. | VI. | 50 | 300 | 2,101 | 247·5 | 8·3 | 105 | 30·0 | 2600 | 4,920 | 8·6 | 1770 | 4·7 | 1207 | 2·9 | 996 | 2·2 |
| 6-in. B.L.R. | VIII. | 50 | 300 | 2,101 | 247·5 | 8·6 | 105 | 37·0 | 2800 | 5,707 | 11·3 | 1923 | 5·2 | 1297 | 3·2 | 1026 | 2·3 |
| 7-in. B.L.R. | II. | 45 | 323 | 3,643 | 259·8 | 12·7 | 165 | 58·0 | 2700 | 8,338 | 9·6 | 1948 | 6·4 | 1382 | 4·2 | 1083 | 3·0 |
| 8-in. B.L.R. | III., IV. | 35 | 305 | 3,170 | 245·8 | 13·1 | 260 | 43·8 | 2100 | 7,948 | 8·6 | 1576 | 6·0 | 1206 | 4·2 | 1040 | 3·6 |
| 8-in. B.L.R. | V. and VI. | 45 | 369 | 5,243 | 299·1 | 18·7 | 260 | 98·5 | 2750 | 13,360 | 12·0 | 2106 | 8·6 | 1589 | 6·1 | 1227 | 4·4 |
| 10-in. B.L.R. | I., II. | 30 | 329 | 6,779 | 251·1 | 25·1 | 510 | 90·0 | 2000 | 14,141 | 10·7 | 1590 | 8·0 | 1274 | 6·1 | 1103 | 5·0 |
| 10-in. B.L.R. | III. | 40 | 413 | 10,222 | 327·0 | 34·6 | 510 | 207·5 | 2700 | 25,772 | 19·4 | 2184 | 11·9 | 1747 | 9·0 | 1406 | 6·9 |
| 12-in. B.L.R. | I., II. | 35 | 441 | 11,991 | 345·2 | 45·3 | 870 | 160·0 | 2100 | 26,596 | 14·2 | 1733 | 11·2 | 1433 | 8·8 | 1219 | 7·2 |
| 12-in. B.L.R. | III., IV. | 40 | 493 | 17,096 | 392·2 | 52·1 | 870 | 237·5 | 2400 | 34,738 | 19·8 | 1994 | 13·3 | 1649 | 10·5 | 1376 | 8·3 |
| 12-in. B.L.R. | III., IV. | 40 | 493 | 17,096 | 392·2 | 52·1 | 870 | 305·0 | 2600 | 40,768 | 18·5 | 2171 | 14·8 | 1801 | 11·7 | 1500 | 9·3 |
| 12-in. B.L.R. | V. | 45 | 553 | 16,974 | 452·0 | 52·9 | 870 | 305·0 | 2700 | 43,964 | 19·4 | 2259 | 15·5 | 1877 | 12·3 | 1561 | 9·8 |
| 12-in. B.L.R. | VI. | 45 | 553 | 14,970 | 452·0 | 53·6 | 870 | 340·0 | 2850 | 48,984 | 20·8 | 2393 | 16·6 | 1991 | 13·3 | 1653 | 10·0 |
| 12-in. B.L.R. | VII. | 50 | 607 | 14,296 | 506·3 | 56·1 | 870 | 340·0 | 2950 | 52,483 | 25·7 | 2483 | 17·5 | 2071 | 13·9 | 1719 | 11·0 |
| 13-in. B.L.R. | I., II. | 35 | 479 | 15,068 | 374·9 | 61·4 | 1130 | 180·0 | 2000 | 31,333 | 15·0 | 1679 | 12·0 | 1414 | 9·7 | 1221 | 8·1 |
| 14-in. B.L.R. | I.[1] | 45 | 642 | .. | .. | 63·6 | 1400 | 365·0 | 2600 | 65,606 | 28·3* | .. | 23·4* | .. | .. | .. | .. |
| 14-in. B.L.R. | II.[2] | 50 | 700 | .. | .. | 82·2 | 1400 | .. | 2800 | 76,180 | .. | .. | 27·4 | .. | .. | .. | .. |

[1] Pennsylvania class. [2] New Mexico class. For the 16-in. gun see the Bethlehem table, page 400.

* Harveyized armour. † A short anti-aircraft 3-in. gun is mounted in many of the ships. ‡ There is now a 4-in. 50-cal. anti-aircraft gun.

§ All battleships from the Delaware class onward have this gun for torpedo defence.

Corrected to 1921.

# BETHLEHEM STEEL CO.

## ORDNANCE.

**Table supplied by the Manufacturers, September, 1921.**

| Calibre. | | Length of bore. | Weight of gun, including breech mechanism. | | Weight of projectile. | | At Muzzle. | | | | | | Ammunition. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Velocity. | | Energy. | | Penetration of steel-plate (De Marre). | | |
| inches. | millimetres. | calibres. | lbs. | kgs. | lbs. | kgs. | ft. per sec. | metres per sec. | foot-tons. | metre-tons. | inches. | milli-metres. | Type. |
| 1·457 | 37 | about 50 | 160 | 72·5 | 1·07 | 0·48 | 2,150 | 655 | 34 | 10·5 | 2·04 | 51·8 | Fixed in cartridge case. |
| 1·850 | 47 | about 50 | 550 | 249·5 | 3·3 | 1·5 | 2,400 | 732 | 132 | 41 | 4·11 | 104·4 | " " |
| 2·244 | 57 | 50 | 960 | 435·5 | 6·07 | 2·75 | 2,400 | 732 | 243 | 75 | 5·17 | 131·3 | " " |
| 3 | 76·2 | 50 | 1950 | 884·5 | 13 | 5·9 | 2,700 | 823 | 658 | 204 | 7·71 | 195·8 | " " |
| | | | tons. | | | | | | | | | | |
| 4 | 101·6 | 50 | 2·6 | 2,642 | 33 | 15 | 2,800 | 853 | 1,795 | 557 | 11·61 | 294·9 | " " |
| 4 | 101·6 | 50 | 2·6 | 2,642 | 30·86 | 14 | 3,000 | 914 | 1,928 | 597 | 12·22 | 310·4 | " " |
| 5 | 127 | 51 | 5·0 | 5,080 | 50 | 22·7 | 3,150 | 960 | 3,440 | 1,067 | 14·56 | 369·8 | " " |
| 6 | 152·4 | 45 | 7·0 | 7,112 | 105 | 47·6 | 2,600 | 792 | 4,926 | 1,523 | 15·47 | 392·9 | Separate, with powder in bag. |
| 6 | 152·4 | 50 | 8·4 | 8,534 | 105 | 47·6 | 2,800 | 853 | 5,713 | 1,767 | 17·19 | 436·6 | Separate, with cartridge case. |
| 6 | 152·4 | 53 | 10·1 | 10,262 | 105 | 47·6 | 3,000 | 914 | 6,559 | 2,028 | 18·97 | 481·8 | Separate, with powder in bag. |
| 7 | 177·8 | 45 | 12·7 | 12,903 | 165 | 74·8 | 2,700 | 823 | 8,348 | 2,584 | 19·11 | 485·4 | " " " |
| 7 | 177·8 | 50 | 14·5 | 14,732 | 165 | 74·8 | 2,900 | 884 | 9,631 | 2,982 | 21·16 | 537·5 | " " " |
| 8 | 203·2 | 45 | 18·6 | 18,898 | 260 | 118 | 2,800 | 853 | 14,148 | 4,379 | 24·15 | 613·4 | " " " |
| 8 | 203·2 | 50 | 22·3 | 22,657 | 260 | 118 | 2,900 | 884 | 15,177 | 4,703 | 25·38 | 644·6 | " " " |
| 9·2 | 233·7 | 50 | 30·4 | 30,886 | 380 | 172 | 2,900 | 884 | 22,181 | 6,856 | 28·66 | 727·9 | " " " |
| 10 | 254 | 45 | 35·4 | 35,966 | 515 | 234 | 2,800 | 853 | 28,023 | 8,685 | 30·97 | 786·6 | " " " |
| 10 | 254 | 50 | 43·9 | 44,602 | 515 | 234 | 2,900 | 884 | 30,061 | 9,327 | 32·56 | 827·0 | " " " |
| 12 | 304·8 | 45 | 53·8 | 54,660 | 870 | 395 | 2,800 | 853 | 47,341 | 14,660 | 37·05 | 941·1 | " " " |
| 12 | 304·8 | 50 | 66·0 | 67,056 | 870 | 395 | 2,900 | 884 | 50,783 | 15,745 | 38·95 | 989·3 | " " " |
| 14 | 355·6 | 45 | 66·0 | 67,056 | 1,400 | 635 | 2,600 | 792 | 65,687 | 20,317 | 39·69 | 1008·0 | " " " |
| 14 | 355·6 | 50 | 80·0 | 81,280 | 1,400 | 635 | 2,800 | 853 | 76,181 | 23,567 | 44·12 | 1121 | " " " |
| 15 | 381 | 45 | 86·5 | 87,884 | 1,700 | 771 | 2,600 | 792 | 79,763 | 24,668 | 42·35 | 1076 | " " " |
| 16 | 406·4 | 45 | 105·0 | 106,680 | 2,100 | 953 | 2,600 | 792 | 98,530 | 30,491 | 45·95 | 1167 | " " " |
| 16 | 406·4 | 50 | 128·0 | 130,048 | 2,100 | 953 | 2,800 | 853 | 114,272 | 35,369 | 51·08 | 1297 | " " " |
| 18 | 457·2 | 45 | 150·0 | 152,400 | 3,330 | 1,510 | 2,450 | 747 | 138,734 | 42,979 | 51·71 | 1313 | " " " |

Guns of 3-in. calibre and under, equipped with the wedge-type breech mechanism, are supplied with an automatic breech-opening device, if desired.

# GERMAN SHIP AND COAST GUNS (KRUPP).

This list of Krupp guns was corrected in September, 1921. It is a valuable record of the guns which were produced at Essen shortly before the war, and during its course up to the time when the provisions of the Armistice came into force. Under the Peace Treaty the delivery of German war material abroad is interdicted. The most important of the new guns were those of heavy calibres: 16 in., 18 in. and 20 in. The pre-war table showed no guns of greater length than 40 calibres below the 11 in. The Essen company has always attached the greatest importance to the endurance and performances of its heavy guns.

| Calibre . . . . . . . cm. | 7·5 = 2·9 in. | | 8·8 = 3 4 in. | | 10·5 = 4·1 in. | | 15 = 5·9 in. | | 21 = 8·2 in. | | 24 = 9·4 in. | | 28 = 11 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of Bore . . . . cals. | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 |
| Length of Bore . . . . mm. | 3375 | 3750 | 3960 | 4400 | 4725 | 5250 | 6710 | 7455 | 9420 | 10465 | 10800 | 12000 | 12600 | 14000 |
| Total Length . . . . ,, | 3570 | 3945 | 4190 | 4630 | 5000 | 5525 | 7100 | 7845 | 9965 | 11010 | 11425 | 12625 | 13330 | 14730 |
| Weight of Gun . . . . kg. | 760 | 780 | 1225 | 1260 | 2095 | 2140 | 5970 | 6120 | 14600 | 15440 | 21950 | 23250 | 34900 | 36900 |
| Weight of Projectile . . ,, | 5·8 | 5·8 | 9·5 | 9·5 | 16 | 16 | 46 | 46 | 125 | 125 | 190 | 190 | 300 | 300 |
| Weight of Charge . . . ,, | 1·84 | 1·84 | 2·97 | 2·97 | 5·05 | 5·05 | 14·4 | 14·4 | 38·8 | 38·8 | 58·3 | 58·3 | 92·7 | 92·7 |
| Muzzle Velocity . . . m/sec. | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 |
| Muzzle Energy . . . . mt. | 213·5 | 226·5 | 350 | 371 | 590 | 625 | 1694 | 1797 | 4610 | 4880 | 7000 | 7420 | 11040 | 11700 |
| Muzzle Penetration (Steel) mm. | 206 | 215 | 247 | 258 | 297 | 310 | 433 | 452 | 616 | 642 | 717 | 747 | 842 | 878 |

| Calibre . . . . . . . cm. | 30·5 = 12 in. | | 35·56 = 14 in. | | 38·1 = 15 in. | | 40·64 = 16 in. | | 45·72 = 18 in. | | 50·8 = 20 in. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length of Bore . . . . cals. | 45 | 50 | 45 | 50 | 45 | 50 | 45 | 50 | 44 | 50 | 45 | 50 |
| Length of Bore . . . . mm. | 13725 | 15250 | 16000 | 17780 | 17145 | 19050 | 18290 | 20320 | 20575 | 22860 | 22860 | 25400 |
| Total Length . . . . ,, | 14520 | 16045 | 16925 | 18705 | 18135 | 20040 | 19345 | 21375 | 21765 | 24050 | 24180 | 26720 |
| Weight of Gun . . . . kg. | 45100 | 47700 | 70000 | 75200 | 86100 | 92500 | 104300 | 112200 | 148300 | 159500 | 204000 | 219000 |
| Weight of Projectile . . . ,, | 390 | 390 | 620 | 620 | 760 | 760 | 920 | 920 | 1310 | 1310 | 1805 | 1805 |
| Weight of Charge . . . ,, | 120 | 120 | 190 | 190 | 233 | 233 | 284 | 284 | 402 | 402 | 553 | 553 |
| Muzzle Velocity . . . m/sec. | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 | 850 | 875 |
| Muzzle Energy . . . . mt. | 14350 | 15230 | 22800 | 24200 | 27950 | 29650 | 33900 | 35950 | 48250 | 51200 | 66500 | 70500 |
| Muzzle Penetration (Steel). mm. | 927 | 967 | 1095 | 1142 | 1177 | 1227 | 1259 | 1312 | 1428 | 1488 | 1600 | 1668 |

## SIZE AND FIGHTING QUALITIES OF BRITISH BATTLESHIPS OF DIFFERENT PERIODS.

| Name. | Date of Completion. | Displacement. | Side Armour. | Speed. | Total Weight of Shot in One Round. | Collective Energy at Muzzle of One Round. |
|---|---|---|---|---|---|---|
| | | tons. | in. | knots. | lb. | foot-tons. |
| Warrior | 1861 | 9,210 | 4½-in. wrought-iron | 14½ | 3,800 | 61,476 |
| Hercules | 1868 | 8,680 | 9-in. to 6-in. wrought-iron | 14 | 5,400 | 70,200 |
| Alexandra | 1877 | 9,490 | 12-in. to 6-in. wrought-iron | 15 | 5,426 | 71,400 |
| Inflexible | 1881 | 11,880 | 24-in. to 16-in. wrought-iron | 13 | 6,936 | 123,120 |
| Benbow | 1888 | 10,600 | 18-in. compound | 16·75 | 4,600 | 135,560 |
| Royal Sovereign | 1892 | 14,150 | 18-in. and 5 in. compound | 17·5 | 5,800 | 159,610 |
| Barfleur | 1894 | 10,500 | 12-in. compound | 18·5 | 2,450 | 67,670 |
| Canopus | 1900 | 12,950 | 6-in. hardened steel | 18·25 | 4,600 | 178,720 |
| Prince of Wales | 1902 | 15,000 | 9-in. super-hardened steel | 18·25 | 4,600 | 194,400 |
| King Edward VII. | 1905 | 16,350 | 9-in. hardened steel | 19 | 6,100 | 271,800 |
| Dreadnought | 1906 | 17,900 | 11-in. hardened steel | 21 | 8,800 | 487,100 |
| Neptune | 1911 | 20,600 | 12-in. hardened steel | 21·5 | 8,900 | 545,000 |
| Ajax | 1913 | 25,000 | 12-in. hardened steel | 21·5 | 14,500 | 625,000 |
| Queen Elizabeth | 1914 | 27,500 | 13-in. hardened steel | 25 | { about 16,400 } | 710,000 |

PARTICULARS OF SUCCESSIVE LARGE BRITISH NAVAL GUNS, 1800 TO 1921.

| Year. | Type. | Weight. | | Length. | Calibre. | Weight of Projectile. | Weight of Charge. | Muzzle Energy. | Penetration of Wrought-iron at 1000 yards range. |
|---|---|---|---|---|---|---|---|---|---|
| | | tons. | cwt. | in. | in. | lb. | lb. | ft.-tons. | in. |
| 1800 | Cast-iron smooth-bore | 2 | 12 | 114 | 6·4 | 32 | 10 | 400 | — |
| 1842 | Ditto | 4 | 15 | — | 8·12 | 68 | 16 | 700 | — |
| 1865 | Woolwich wrought-iron | 4 | 10 | — | 7 | 115 | 22 | 1,400 | 7 |
| 1870 | Built-up muzzle-loader | 38 | 0 | 200 | 12·50 | 810 | 200 | 13,900 | 17 |
| 1880 | Ditto | 80 | 0 | 321 | 16 | 1700 | 450 | 27,960 | 22½ |
| 1887 | Built-up breech-loader | 110 | 10 | 524 | 16·25 | 1800 | 960 | 54,390 | 32 |
| 1895 | Wire-wound breech-loader | 46 | 0 | 445·5 | 12 | 850 | — | 33,940 | 34·6 |
| 1900 | Ditto | 51 | 0 | 496·5 | 12 | 850 | 210 | 36,290 | 35·4 |
| 1905 | Ditto | 58 | 0 | 558 | 12 | 850 | — | 47,700 | 46·2 |
| 1912 | Ditto | 76 | 0 | 626 | 13·5 | 1400 | — | 60,600 | *50 |
| 1914 to 1920 | Ditto | 97 | 0 | 675 | 15 | 1900 | — | 82,300 | *56 |
| 1921 | Ditto | 117 | 0 | 720 | 16 | 2240 | — | 93,230 | *57 |

* At muzzle. Guns of 18-in. calibre were fitted to one cruiser during the War, but were subsequently removed and used in monitors.

# FIRST LORD'S STATEMENT EXPLANATORY OF THE NAVY ESTIMATES, 1921-1922.

THE Estimates for 1921-22 amount to £91,186,369 gross, and £82,479,000 net, as compared with £105,283,281 gross, and £90,872,300 net, in 1920-21. This is a reduction of over 14 millions on the gross estimate, and of over 8¼ millions on the net estimate.

Non-recurrent war liabilities, or terminal charges, amount to about 8¼ millions, including about 3¼ millions for completion of the Light Cruisers, Air-Craft Carriers, Destroyers and Submarines, begun during the war. It is anticipated that very few charges of this nature will remain to be liquidated after the end of the year 1921-22.

In my predecessor's Explanatory Statement of last year, a comparison was made with the Estimates for 1914-15. Without repeating the same details, I may mention that the gross estimate of £91,186,869 for 1921-22, which includes 3¼ millions for completion of ships in hand, and 2½ millions for commencing the replacement of obsolescent ships, corresponds (after the necessary deductions have been made for non-recurrent war liabilities, and increases in prices, wages, pensions, etc.) with a pre-war figure of about £34,500,000 (gross). The actual figures in 1914-15 were £53,573,261 (gross). There is consequently a comparative decrease of over 19 millions on the present estimates, as compared with 1914-15.

Estimates can only be based upon Policy, and the Naval Policy of the Government, as announced by my predecessor, in the House of Commons, on March 17, 1920, is to maintain a "One-Power Standard"—*i.e.* that our Navy should not be inferior in strength to that of any other Power. The duty of the Admiralty is to carry out that policy as economically as possible, giving full weight to the special geographical, international, and other considerations which have arisen since the war. This they are doing—in no mechanical spirit nor with insistance upon "numerical equality"—and, recognising to the full the necessity for reducing expenditure to the lowest limits compatible with national security, the Admiralty have effected drastic economies, and agreed to assume risks which, in ordinary circumstances, they would regard as difficult to reconcile with the full maintenance of the Government's declared policy.

The details of these economies will be apparent in the Votes; but it may be here mentioned that they include:—

(*a*) The reduction of the number of capital ships in full commission, from 20 to 16 (as compared with 38 in March, 1914). This is the smallest number that will enable the essential seagoing and technical training of officers and men to be properly carried out.

(*b*) The placing in reserve of one of the four destroyer flotillas of the Atlantic Fleet.

(*c*) The reduction of the North American and South African Squadrons by one light cruiser each, and the complete (temporary) withdrawal of the South American Squadron.

(*d*) The reduction of the personnel of the Fleet during 1921, to 121,700 officers and men (as compared with 127,500 in 1920, and 151,000 in 1914).

(*e*) The reduction of Civil Staffs at the Admiralty and other establishments, and other economies in the dockyards.

These changes are dictated, almost entirely, by the pressing need for economy, and make it incumbent upon the Admiralty to maintain the reduced Navy in a state of the highest possible efficiency.

In pursuance of this policy, the retention in reserve of the eight battleships (Hercules, Colossus, Neptune, St. Vincent, Collingwood, Temeraire, Bellerophon and Superb) which are armed with 12-inch guns, is no longer considered justifiable, and they are transferred to the Disposal List. The number of capital ships on the effective list is thus reduced to 30 (including H.M.A.S. Australia), of which 14 will be in reserve.

Of these 30 ships, the older types are becoming obsolescent, and cannot be reckoned as efficient fighting units for more than a few years longer. The need for their gradual replacement by modern ships, embodying the lessons of the war, can therefore no longer be disregarded. In this connection, it must be remembered that no capital ship for the Royal Navy has been laid down and completed since 1916, and it is obvious that, as the Fleet is reduced in numbers, the ships of which it is composed must be of up-to-date type and of the highest efficiency. A sum of $2\frac{1}{2}$ millions has therefore been included in these Estimates as a first instalment for "replacement" ships. Further details of the proposed expenditure will be laid before Parliament as soon as possible.

It cannot be too strongly emphasised that, in making this long-delayed beginning with the replacement of obsolete ships, the Government neither commits itself to, nor contemplates, any building "Programmes" in answer to those of any other Power. Indeed, it trusts that it may be possible, as a result of frank and friendly discussion with the principal Naval Powers, to avoid anything approaching to competitive building, either now or in the future. But, meanwhile, it would be a dereliction of duty on the part of the Admiralty to allow the efficiency, training, or morale of the Royal Navy to deteriorate, through neglect to provide it with matériel which is equal to the best and in which it can feel confidence. It is also imperative to avoid an irrevocable loss of time and building facilities which might make it impossible to maintain our sea security if it should be threatened.

It is upon this basis of policy, and with a full realisation of the vital need for economy that these Estimates have been framed.

LEE OF FAREHAM.

Admiralty,
March 12, 1921.

## MEMORANDUM.

### (*Supplemental to the Explanatory Statement.*)

*Co-operation with the Dominions.*

The Imperial Conference which is to take place in June of this year will give a welcome opportunity for discussing fully with the Dominion Representatives the problem of Naval Policy in relation to the Empire as a whole, and for the consideration of suggestions for mutual co-operation.

The lines on which it would be proposed to proceed are towards the development of Dominion Navies under the administrative and executive command of their own Officers, each separate Navy being the responsibility of its own Government, and imbued with the particular characteristics and spirit of its own people, all, however, working in close co-operation and under the guidance of a common doctrine. If war occurred in which the Empire as a whole took part, then the various component Navies would work in harmony with the general strategical policy previously decided upon. To ensure such intelligent co-operation, common principles of command and Staff work are required. This can only be developed by a uniform system of Staff training. It is proposed to make gradual progress in this direction by the appointment of Dominion Officers to the Naval Staff at the Admiralty, and by arranging for a certain proportion of Dominion Officers each year to undergo the Naval Staff Course at the Staff College. Finally, it is hoped to arrive at a position when the Dominions themselves will be able to set up their own Staff Colleges, working on the same lines and under the same system as the Naval Staff College at home.

The machinery required to give effect to these tentative proposals regarding Imperial Naval Policy, and to ensure the building up of Navies with a common doctrine and working to a common plan, cannot be indicated until this matter has been considered in conjunction with the Dominion Representatives, and their views have been fully stated.

*Staff Training and Organisation.*

The system of Staff Training and Organisation outlined in the Notes on Naval Policy, 1920–21, has been proceeded with, and the Naval Staff at the Admiralty has now been reduced to the dimensions which were anticipated, namely, eight Divisions, with a total personnel of 86. This, in the opinion of the Admiralty, represents the limit of reduction consistent with economy and efficiency. The strengthening of that side of the Naval Staff under the Assistant Chief of Naval Staff which deals with the use and development of weapons and the requirements of design, and which was the main feature of the Staff changes introduced last year, has enabled the technical lessons of the war to be exhaustively examined and applied, especially in the direction of improving design.

The first course for training Naval Staff Officers was completed in June, 1920. Sixteen Officers qualified, and are now employed on Staff duties. Thirty-one Officers are at present undergoing Staff training at the R.N. College, Greenwich, this number representing the limit of accommodation at that establishment.

Effort is being made to arrange that the Naval Staff College shall be in touch with the Military Staff College, in order that the Naval and Army Officers under training may interchange ideas, and, to a certain extent, be trained under a common system, so that each will understand the requirements of the other Service. In seeking to improve the co-operation of the Services in defence matters, it is clearly of importance to have in the Services a body of Staff Officers who will bring to bear on all higher strategical questions the knowledge and understanding of each others' requirements which are gained by personal association.

The Courses for Senior Officers referred to last year have proved of considerable value. Two of these Courses are held annually at the Royal Naval College, Greenwich, and it is hoped that all Captains will have an opportunity of attending soon after their promotion.

In addition to the Greenwich Course, technical Courses are held at Portsmouth for these Officers with the object of supplying them, before they assume command afloat, with the latest information as to the development and employment of weapons and communications.

*Personnel.*

*Reduction of Officers' Lists.*

The special facilities for retirement which were introduced last year with the object of reducing the surplus of Officers resulting from the expansion necessitated

by the war, have on the whole been attended with satisfactory results, upwards of 1,100 Officers having taken advantage of the terms offered, but the numbers borne now are still considerably greater than actual requirements.

On the other hand, there is in some branches an actual shortage, mainly of Schoolmasters, Instructor, Dental, and especially Medical Officers. This is to be attributed to the reduction in the supply of qualified candidates owing to the war and to the increased rates of pay obtainable in civil life. Careful consideration is being given to such measures as can be adopted in existing circumstances to remedy this state of affairs.

*Specialist Officers.*

There has unfortunately been some falling off in the number of Officers volunteering to specialise in certain subjects, mainly in Gunnery. This is a matter seriously affecting the efficiency of the Fleet and is, no doubt, to be attributed chiefly to the reduction in the rates of allowances granted to qualified Officers which accompanied the new rates of pay introduced in 1919.

Temporary arrangements have been made to mitigate the effects of this shortage by utilising the services of less highly qualified Officers, but this can only be regarded as a palliative, and further measures will be necessary if the Gunnery efficiency of the Fleet is to be maintained at a high standard. This matter is engaging serious attention.

The Navy has become now such a specialist Service that a very much larger proportion of Officers are required to specialise than formerly, in fact it is estimated that 70 per cent. of the Cadets entering must take up one or other of the subjects in order to provide sufficient numbers.

### *University Training of Officers.*

The arrangements mentioned last year for the instruction at Cambridge University of the young officers whose normal training was interrupted by the war, are proceeding satisfactorily, and the cordial thanks of the Admiralty are due to the University Authorities for their generous support in rendering the scheme a success. The University Authorities are giving every assistance, but owing to the other demands on the resources of the University in the matter of accommodation, the training of the large number of Officers still affected will not be completed before 1923.

### *Deck and Engineer Officers.*

The steps taken with regard to the Deck and Engineer Officers have been in continuation of the policy set out in full in the Notes on the Estimates, 1920–21.

During the past year the measures necessary to ensure the efficiency of the Engineering Branch of the Service, whilst adhering to the principles of common entry and early separation, have been under close consideration, and as a consequence it is proposed to introduce certain modifications in the present system of Engineering training.

*Firstly*, in the opinion of the Board of Admiralty, the time has arrived for arranging gradually to transfer the duties in connection with the Electrical Installations of H.M. Ships from the charge of the Torpedo Lieutenant, a Deck Officer with whom it is vested at present, to the Engineering side. The maintenance in an efficient condition of electrical machinery is a similar function to that of the maintenance of other machinery on board ships; it is not the province of the Deck Officer, who is concerned with the handling of ships, the employment of weapons and the strategical and tactical problems of war.

The proposals, therefore, for the future training of Officers for the Engineering branch make provision for a proportion of those Officers to become electrical engineering specialists.

*Secondly*, it has been deemed desirable to arrange for separation between Deck and Engineering Branches to take place earlier than has hitherto been the case. The period of common training at Dartmouth College and in the training battleship will, it is considered, have been sufficient to give the Cadets a general education similar to that received at a Public School, and in addition a common understanding of the ideals and discipline of the Naval Service, after which it is now proposed that the two branches shall diverge. Those on the Deck side require immediate sea experience, those on the Engineering side, on the other hand, require, before proceeding to sea, to receive a thorough grounding in engineering and electricity, and to undergo a period of practical work in the workshops. For this purpose they will first proceed for three years' training at the Engineering College at Keyham, and will undergo a course similar to the one which all Engineer Officers in H.M. Navy formerly underwent, and which gave us the splendid body of Officers to whom we owe the engineering efficiency of the Fleet during the war. On completion of this course they will then proceed to sea to carry out engineering duties afloat. Specially

selected Officers will be given the appropriate advanced courses at Greenwich and as may be necessary. Those Officers who have qualified in the advanced marine engineering course will be eligible as at present for the higher posts; those who have qualified in the advanced electrical course will be employed in ships requiring them and will be eligible for selection for the higher electrical positions. As Specialist Electrical Officers become available the electrical installations in the more important ships now in charge of Torpedo Lieutenants will be transferred to them, and in the less important ships the electrical installations will be in charge of an Engineer Officer.

### *Training of Cadets and Junior Officers.*

The Royal Naval College at Osborne will be closed in April, and the training of the Cadets entered under the Common Entry Scheme described last year will thereafter be concentrated at Dartmouth. This will, of course, effect a considerable economy.

The reduced numbers of Cadets in the terms now to be dealt with will make it possible to concentrate the seagoing training of all Cadets, including the Special Entry Cadets and Paymaster Cadets, in one vessel next term. H.M.S. Thunderer has been selected for this duty and will commission in May, and the present Training Ships, Temeraire and Carnarvon, will be paid off.

The question of the further training of the Junior Officers who are now completing their period at sea as Midshipmen under peace conditions has also been engaging careful attention.

Prior to the war the courses on shore for such Officers were limited to about 3 months, but experience has shown that an extension of the courses is necessary.

It is therefore under consideration to allow the Officers to undergo a course of general and theoretical instruction at the R.N. College at Greenwich, and to increase the length of the courses in professional subjects in the light of recent developments.

### *Air Training of Officers.*

Arrangements have been made with the Air Ministry for the training of a number of Naval Officers as Observers for duty with the Fleet. These Officers will receive a general training in air work and will be available for duty with the Fleet in the Aircraft-Carriers.

### *Promotion from the Lower Deck. General.*

The scheme announced in the Notes on Naval Policy last year which had for its object the reduction in the ages of candidates for promotion from the Lower Deck, thereby enabling them to reach the rank of Lieutenant at an age more nearly approximating to that of Officers entered through the regular channels, is now in operation, but sufficient time has not yet elapsed to enable the full result of the changes to be estimated.

It is hoped that the facilities offered will be taken advantage of by the most capable of our young seamen, and that, as in the past, an appreciable number of Officers will be obtained from this source.

### *Engineer Officers. Entry from Boy Artificers.*

It is the intention that in addition to the Cadets selected for Engineering from the Dartmouth Training Establishment, specially selected lads from the Boy Artificer Training Establishment who have specially distinguished themselves during their course of training, should proceed with those of the Dartmouth Cadets who take the Engineering side of the profession to the Keyham College; thenceforward such Boy Artificers will work side by side with the Dartmouth Cadets, passing through the Keyham Establishment, thence to sea, and, if selected, to Greenwich for the higher Courses. It will be possible for these boys on their merits to reach the higher ranks in H.M. Service.

### *Marriage Allowance.*

Marriage allowance has been introduced during the last year for Ratings in the Service. This was carried out on the recommendation of an Inter-Departmental Committee—Admiralty, War Office, and Air Council—and is the same for the men of all three Services.

### *Uniform.*

During the last year the so-called "Fore and Aft" rig has been introduced for Petty Officers of over four years' seniority.

*Reserves.*

*Royal Naval Reserve and Volunteer Reserve.*

The recommendations of a Committee appointed in March, 1920, to consider alterations necessary in the arrangements then existing for enrolling, training, and employing Officers and Men of the permanent Royal Naval Reserve and Royal Naval Volunteer Reserve Forces, and to frame the organisation necessary to permit of the rapid expansion of these forces on the outbreak of war, have now received the approval of the Board of Admiralty and the sanction of the Treasury, and the new regulations consequent on the adoption of these recommendations are being issued and brought into force.

Courses in Gunnery, Torpedo, and Signals for the R.N.R. were in force under the old regulations, and the scheme of training has been extended to include special courses in Navigation, Submarine, Patrol, Minesweeping, Minelaying, and Anti-Submarine Services, the intention being to provide a Reserve of seafaring Officers and men trained in the branches of Naval warfare in which the experience of the late war has shown that their services would be required in any future hostilities.

With a view to providing to some extent for the necessary expansion of the Engineering Branch in the event of war or emergency, a Special Reserve of Engineer Officers has been formed from the temporary Engineer Officers, R.N., who served in the Fleet during the war. These Officers will be required to undergo 14 days' training each year, or 28 days' every two years, and may volunteer for 12 months' temporary service in the Fleet.

A similar extension of the scheme of training for the R.N.V.R. has been made, in order that this Force may, in like manner, be better equipped for the duties on which it would be employed in war time.

The total numbers authorised for the financial year 1921-22 are :—

| | |
|---|---|
| *R.N.R.*— | |
| Officers . . . . . . | 2,029 |
| Men . . . . . . . | 9,000 |
| *R.N.V.R.*— | |
| Officers . . . . . . | 484 |
| Men . . . . . . . | 5,000 |

Recruiting to complete to these numbers of R.N.R. men is in active progress.

No Deck Officers, and only a small number of Engineer and Accountant Officers are required to complete the number of R.N.R. Officers authorised, and Midshipmen are being entered to provide for wastage in the future.

In connection with the re-organisation of the R.N.V.R., drill batteries are being re-armed, and drill ships are being fitted out for certain Divisions which require them. Revised establishments of training equipment and stores have been prepared and supply is now being made. Preparation for recruiting at an early date is well advanced and a nucleus of the instructional staff has been appointed to all Divisions. Arrangements for clothing and kitting up of the men are in hand.

A summary of the new conditions of service in the R.N.R. and R.N.V.R. was given to the House in the statement of the Parliamentary Secretary of the Admiralty on December 14, 1920.

*Scientific Research.*

The erection of the Naval Research Institution at Teddington in close proximity to the National Physical Laboratory is now well forward, and it is hoped it will be complete by the end of the present financial year. As regards Shandon, scientific work there has ceased and the transfer of stores to Teddington is proceeding.

It is intended that facilities for actual sea experimental work shall be supplied by the existing experimental establishments. The Staff of the Scientific Department at the Admiralty will, when research has reached a suitable stage of development, be able to continue the work at sea from one of these experimental establishments in co-operation with the Staff at that establishment. In addition, a certain number of the Scientific Staff of the Admiralty Department will work entirely with, and side by side with, the Staff of the Naval Establishments. No hard-and-fast line can be drawn between research and development, and this arrangement will allow of those who are primarily concerned with research being in close contact with those who are primarily concerned with development.

The researches now in hand are more numerous than they were at the beginning of the financial year, and the technical departments of the Admiralty are working in close co-operation to secure the full advantage of these researches.

It may not be out of place to make some reference to the very economical arrangements which have been made in regard to optical research and experiment.

It was arranged earlier in the year that the requirements of the fighting services could best be met by co-operation, and it has been decided that the Admiralty shall maintain an Optical Section at the Naval Research Institution which shall carry out research and experiment for both the Navy and Army. Until the Admiralty building at Teddington is complete, arrangements have been made for the Optical Section to be housed by the National Physical Laboratory. In a somewhat similar way it has been possible to centralise research work in Gyroscopes, it having been decided to continue such research work at the Royal Naval College, Greenwich.

*Matériel.*

The Admiralty are fully alive to the necessity of keeping pace with the development of other types of vessels and other weapons which become an increasing menace to the capital ship, and in the design of the new ships it is necessary to improve their offensive and defensive powers against such new dangers as they may have to meet.

*Gunnery and Torpedo.*

The development of Gunnery and Torpedo has proceeded along well-defined lines, and satisfactory progress has been made in the Fleets in continuing the investigation of the many problems awaiting solution, in the use of armaments of the various types of vessels, and in training the personnel in those methods,

Valuable lessons have been learnt from experimental firings. During the present year it is the intention to fire at an obsolete battleship converted for use as a moving target. It is anticipated that the use of this vessel will greatly facilitate the solution of gunnery problems, in addition to providing most valuable instruction to the personnel of the Fleet.

*Anti-Submarine Work.*

The importance of research work in connection with the anti-submarine devices has been kept continuously in view, as progress in this direction must have a profound effect in regard to requirements of design and types of vessels in the future. The Anti-submarine School has been set up in the existing buildings at Portland, and already there is considerable promise for the future in certain detection devices under trial. Three vessels attached to the School at Portland are specially fitted for the practical experiments which are being pursued, the Officers carrying out these trials being in close touch with the Scientific Establishments concerned, thus ensuring that theoretical and practical requirements receive due weight.

*Commercial Application of Scientific Devices.*

A division of the Naval Staff has been made responsible for keeping in view and formulating proposals for the commercial application of scientific devices, originally developed for Naval purposes, which may be suitable for commercial application.

One of these—Leader Gear—is a device for leading ships into harbour when, as in fogs, ordinary navigational aids cannot be used. The Admiralty propose to lay out a Leader Cable in a position where its commercial application can be fully demonstrated, in order that the Mercantile Marine may have every opportunity of investigating the practical commercial value of the device. It is believed that the adoption of Leader Gear off the entrances to some of our commercial ports will prevent considerable losses both of time and material.

*Directional Wireless Telegraphy.*

Directional Wireless Telegraphy was developed during the War for the purpose of giving H.M. Ships their position at sea. Many stations were set up on the coasts of the United Kingdom, and several of these, since the Armistice, have been placed at the disposal of ships of the Mercantile Marine to enable them to obtain bearings, a small charge being made in each case.

Considerable use has been made of the system, but as the stations are not required in peace time for naval work, they are being turned over to the Post Office with the exception of one which will be employed on development and research work.

*Naval Air Development.*

During the year the Naval Staff has been in close co-operation with the Air Staff both in matters of development and the tactical use of Aircraft for Naval purposes.

The information gained from exercises and experiments has been fully interchanged, and specifications for improved designs of Aircraft have been laid down.

The composition of the Air Units required for Fleet co-operation has been

determined, and it is hoped that during this financial year the air equipment of our Fleets with heavier-than-air craft will make a big stride.

The provision of airships for the Navy has had to be suspended. The Air Ministry informed the Admiralty that the economies imposed upon them in the preparation of the Air Estimates would compel them to reduce considerably the provision of heavier-than-air craft unless the Airship Service was suspended. The Admiralty considered that any such reduction in the vital Naval requirements in heavier-than-air craft, which are essential to Naval efficiency, and to which Naval Votes are heavily committed in the provision of Aircraft-Carriers, could not be accepted.

While the Admiralty regret the decision of the Air Ministry to suspend the Airship Servive, they realise that in view of the stringent financial restrictions, no other decision could have been arrived at.

The limited funds now available to meet Naval Air requirements will, therefore, be expended on heavier-than-air craft instead of on Airships.

In view of the importance of training R.A.F. personnel in Naval work, arrangements have been made to put an Aircraft-Carrier at the disposal of the Air Ministry for certain periods for this purpose.

*Dockyards.*

At the present time 56,000 men are employed in H.M. Dockyards. Of these, 51,000 are employed on purely Naval work (including 5,000 specially entered as a temporary measure in accordance with the policy of "short-time") and 5,000 are employed on repayment work largely as a result of the action taken on the Report of the Committee over which Lord Colwyn presided.

The money shown in Vote 8, Section 1, for the new financial year will admit of the continuous employment of only 43,000 "full time" men on Naval work. As regards work on which "short-time" labour can economically be employed, this is fast coming to an end, and the gradual discharge of the surplus men specially taken on cannot therefore be avoided.

As regards the 5,000 men employed on repayment work, it is hoped that a large amount of such work will continue throughout the year, but discharges must be effected as the repayment work is completed.

As pointed out in the First Lord's covering statement in introducing the Estimates for 1920–21, the number of Home Dockyards exceeded the pre-war number by one. With the reduction of the Fleet contemplated in the Estimates for 1921–22, the number of Dockyards (7) is now in excess of Naval requirements. This matter has been given most careful consideration, and the Admiralty propose gradually to reduce and eventually to close Haulbowline and Pembroke. Every effort will be made to distribute the established men among the other yards. The men who become redundant by the closing of these yards are included in the numbers of discharges indicated in the preceding paragraphs. It is expected to complete the closing of Haulbowline during the financial year 1921–22, and of Pembroke in 1922–23. No further Naval work will be taken in hand at either of these yards, but the repayment work now in hand at Pembroke will be completed at that yard.

In connection with the discharges from the yards which will be necessary during the coming financial year, opportunity will be taken to readjust the numbers employed in the various trades, which have got very much out of proportion during the War and Reconstruction periods.

12th March, 1921. L. of F.

## STATEMENT BY PARLIAMENTARY SECRETARY TO THE ADMIRALTY (L. S. AMERY, M.P.), BEFORE THE HOUSE OF COMMONS ON COMMITTEE OF SUPPLY REGARDING THE FOUR NEW BATTLE CRUISERS.

In Section III. of Vote 8, as originally presented to the Committee, a lump sum of £2,500,000, for the replacement of obsolescent ships, was included under a temporary subhead (LL). That lump sum has now been analysed and distributed amongst Votes and sections of Votes to which it properly belongs, though the total Vote concerned remains unaffected. Sums of £227,050 for wages and of £187,000 for material are allocated to Sections I and II of this Vote, respectively. This is mainly in respect of a new minelayer to be laid down at Devonport and a new experimental submarine to be laid down at Chatham. The expenditure on the four new capital ships falls as to £1,876,000 on Section III of Vote 8, and as to £200,000

on Vote 9, of which £160,000 is for work on new guns and £40,000 for inspection and experiments in connection with those guns, while £10,000 is devoted to partial reorganisation of the Government torpedo factory at Greenock. This reorganisation has been necessitated by the fact that the Whitehead torpedo works at Weymouth, from which we were in the habit of securing many essential parts of our torpedoes, have recently closed down. As Greenock is now the only torpedo factory in the country, we are obliged to rearrange our plant there so as to enable the factory to be self-contained and to manufacture everything we require in connection with torpedoes. This £10,000, though taken out of the £2,500,000, has to figure as a Supplementary Estimate technically, because Vote 10 has already been passed.

This £10,000 is specifically to make the torpedoes for the new ships, and in order to make all the parts of these torpedoes we have to rearrange the factory at Greenock.

The policy of laying down four new capital ships this year has already been approved by the Committee. Our policy is not one of competition or of challenge. It is simply and solely a policy of replacing obsolete ships already relegated to the disposal list. The mightiest instrument of power that the world has ever known—that Grand Fleet under whose relentless pressure the Central Empires, for all their furious and sustained effort on sea and land, finally collapsed and crumbled away—that instrument, not only by the actual wear and tear of the War, but by the very experiences of the struggle, has become in a large measure obsolete in our hands. A few hours of actual fighting were sufficient to revolutionise ideas as to the armament and design of battleships. The lessons of those few hours were open to all the world, and other Powers have not been slow to make use of them. At this moment there are under construction whole battle fleets of vessels of a type incomparably more powerful than anything afloat at the Battle of Jutland, and in the face of whose shattering shell-fire all ships of earlier design are liable to instant and complete destruction by the penetration of their magazines. Japan has eight of these vessels, one of which is already completed, and all of which will be completed by 1925, and she has voted money for eight more to be completed by 1928. The United States—not counting four battleships of 32,600 tons equipped with 16-inch guns, vessels considerably more powerful than our latest types, the "Royal Sovereigns" and "Queen Elizabeths"—will have completed by the end of 1924, or the beginning of 1925, no less than twelve of these supreme engines of war, each of over 43,000 tons. In the case, both of Japan and of the United States, we are dealing, not with projects, but with construction which is actually in progress.

We, on the other hand, have only one British post-Jutland capital ship built or building—the "Hood"— and even she is only equipped with 15-inch guns. In view of these facts, no one will venture to suggest that the present programme of replacing obsolete ships which we have just scrapped by four new capital ships to be completed early in 1925 contains any element of challenge or provocation. On the contrary, the Government and the Board of Admiralty are, I fully admit, open to the charge that they are allowing the British Navy to fall below the standard adopted and announced by the Government in March, 1920, and accepting the possibility of its being, for a time, at any rate, inferior in material strength to the Navy of other Powers. I do not wish to minimise the risk which they have faced in this decision. It is a risk only justified, though I believe it is justified, by two considerations. One is the general financial and international situation; the other is the desirability of avoiding any step that would invite a fresh competition in armaments. On the eve of a conference whose main object is to avert the certain waste and eventual disaster of a renewed competition in armaments, this latter consideration will appeal with special force to the Committee.

I may be asked, of course, why we should not in that case postpone the laying down of even those four ships till after the conference. Such a question would, I venture to suggest, be based on a complete misunderstanding of the purpose with which that conference will meet. It will meet in order to see whether by broad agreements on policy it may not be possible to prevent the present shipbuilding programmes of the three greatest naval Powers being further expanded and swallowing ever vaster sums of the world's common stock of treasure in an ever-increasing competition based on mutual fear and distrust. It is not likely that the other great Powers represented at that conference will offer to scrap ships already built or actually building, and in view of the figures in connection with their naval programmes which I have just given to the Committee, it is obvious that the laying down of our four ships, or even of twice their number, cannot affect in any way the problem before that conference. I repeat that the policy embodied in the laying down of these ships is in no sense a policy of competition, and as such a matter open to controversy in connection with this conference. It is perhaps not even an adequate fulfilment of our declared policy that our Navy should not be inferior in

strength to that of any other Power. It is simply a policy of gradual replacement circumscribed within the narrowest limits and postponed to the very latest date which the safety of the Empire will permit.

I have dealt with this matter, so far, only in terms of material, but, after all, the human and personal element is of even greater importance, and on that side I venture to believe that we, with the unique experience of the war behind us, stand well ahead. Indeed, but for their reliance on our superiority in this respect, the Board of Admiralty would never have been prepared to take the admitted risks they are taking in our present modest programme of replacement. The safety, the very existence, of the British Empire are staked, and for the next few years more completely staked than ever, upon the high moral and the professional efficiency of the Navy. But you cannot sustain efficiency indefinitely on obsolete equipment, and even the highest moral is impaired if your officers and men believe that their skill and devotion are to be thrown away and their lives sacrificed for want of ships in which they can feel reasonable confidence in the hour of action. If I may repeat the words used by the First Lord in his statement explanatory of these Estimates, "it would be a dereliction of duty on the part of the Admiralty to allow the efficiency, training, or moral of the Royal Navy to deteriorate through neglect to provide it with material which is equal to the best and in which it can feel confidence." For this reason, if for no other, we cannot afford to postpone any longer making a beginning with a policy of gradual replacement. Nor can we risk an irrevocable loss of time and building facilities which might make it impossible for us to maintain our security if we should be faced by a fresh sudden menace.

It is not customary at this preliminary state in the construction of new ships of war to give to the House of Commons, and so to the world at large, detailed information as to their design. But in the special circumstances of the time, and in view of the approaching international Conference, we have thought it desirable to make an exception, which the Committee must not regard as constituting a precedent, in order to make it clear that, in this matter of design, we are not attempting to steal a march on other Powers, and are only bringing ourselves up to date in modern developments which have already been adopted by our friends and Allies. The four capital ships which are to be laid down will be battle cruisers of the "Hood" type, but with improvements in the matter of protection and armament which will embody the experience of the War and enable them to hold their own with any vessels of their class in other Navies. In view of the fact that all American and Japanese capital ships laid down since the "Hood" are being equipped with 16-inch guns, we have been obliged to follow their example, and our new ships will therefore be armed with 16-inch and not with 15-inch guns.

On the other hand, the dimensions of those ships—and this has been a cardinal principle of their design—will be such as to keep within limits which will obviate the necessity of any larger docks or other accommodation being provided for them other than that already existing. I hope I shall not be pressed by hon. and right hon. Members opposite to give further details at this stage. I think the Committee will realise that my only object in giving as much information as I have done is to show that we are not aiming at any new or costly revolution in naval armaments and are only equipping our Fleet with up-to-date vessels in which both the officers and men who will man them, and the Empire whose existence may depend on them, may have every right to feel confidence.

I have not forgotten that several Members of the Committee, and in particular the hon. Baronet, the Member for Maldon (Sir Fortescue Flannery), have raised the question of responsibility for the design of the new ships, and reference has been made in this connection to recent discussions in the Press on the subject to underwater protection and to the desirability of appointing a special committee on designs, as was done in 1904. As far as this latter Committee is concerned, it was not, of course, a Committee to design new types of ships—these had already been decided on—but only to review certain details of construction. In the present case, too, the demand for a Committee has arisen mainly in connection with the particular feature of bulge protection. I think I can convince the Committee that this question has already been adequately examined. As far back as 1913 a series of exhaustive experiments was begun by the Director of Naval Construction, Sir Eustace Tennyson D'Eyncourt, subsequently assisted by Professor Hopkinson, of the Royal Society, on this method of protection against torpedo attack. The results of these experiments were so encouraging that during the War bulges were added to many of our old ships, and embodied in principle in our larger new ships. In actual practice the bulges proved a complete success. They were completely efficient against torpedo attack, and not a single vessel so protected was lost. The practical experience of the Fleet and the results of experiments since, were, in Augusi, 1918, submitted to a Committee presided over by Lord Jellicoe. That Committee recommended that all

new battleships and battle cruisers should be fitted with full bulge protection, and that a modified form of this protection should be given to smaller vessels. Much of the discussion since then has turned on the question whether the bulge should be internal or external. But that distinction really depends on the assumption that the designs of the bulges applied to new ships will necessarily follow the contour line of the bulges applied to existing ships. That is not so, and, consequently, the distinction is one of definition rather than of substance. In any case, I can assure the Committee that every suggestion, from whatever source, was carefully considered before the present design was adopted, and that the Admiralty are satisfied that they have secured a form of under-water protection which, as far as possible, will meet all contingencies.

Even more fertile as a subject of discussion in the Press has been the question whether we should build capital ships at all, and whether far greater results at the same or even less expense could not be secured by concentrating on smaller craft, more particularly on the submarine and the aeroplane. That question has been exhaustively examined by the naval and constructional staffs of the other great Naval Powers, and I have already informed the Committee what their unanimous answer to it has been. It has naturally also been the subject of most anxious and searching investigation on our part. It was investigated immediately after the Armistice by an Admiralty Committee, and since then it has been continuously under review by the Board of Admiralty and their technical officers. It was again fully re-investigated at the beginning of the present year by a special Sub-committee of the Committee of Imperial Defence, under the chairmanship of my right hon. friend the late Leader of the House (Mr. Bonar Law). Nothing emerged from any of those investigations to change the broad, general and universally accepted conclusion that the capital ship is still the basis on which sea power ultimately rests. I will not attempt to recapitulate all the arguments and considerations which have led to so definite and so authoritative a conclusion. But I would lay stress on a few of the most important. As between surface ships, there can be no possible doubt as to the immense advantage which the larger, more heavily gunned and more powerfully armoured ship possesses over lighter craft. Coronel, the Falkland Islands Jutland, put that beyond dispute. The real issue is whether the submarine and aeroplane have yet reached the point of development at which the capital surface ship has become out of date. The submarine, undoubtedly, is a very formidable engine of war, and it is one which has come to stay. But it is one whose whole power lies in concealment, and for the sake of that concealment it has to sacrifice speed and offensive and defensive power. For the time being, at any rate, that very power of concealment has been most seriously impaired by the remarkable progress made during the closing months of the War, and since, in scientific methods of submarine detection.

The aeroplane has, of course, become an essential and indispensable factor in naval warfare. But it has not yet been proved capable of carrying or discharging with accuracy at a moving target, and in the face of high angle fire, projectiles more formidable than those against which the modern capital ship is already protected. Its range is still very limited; and, except for inshore work, it is dependent upon the aeroplane-carrier; in other words upon a surface ship whose security against other surface ships ultimately rests on the battle-cruiser or battleship. The day of capital aircraft or of the capital submarine may come. But it has not come yet, and, until it does come, the capital surface ship will remain the kernel and pivot of naval warfare. What is true, no doubt, is that all these new elements of naval warfare have acquired an increased relative importance. The fighting fleet of the future can no longer be reckoned in terms of ships of the line. It is a great complex of highly diversified and specialised units, each of which is indispensable to the defensive and offensive power of the whole.

I now come to the question of where these ships are to be built. At this moment the building slips in the Government dockyards are incapable of taking ships of the size of the Hood. That situation is not one in which we can permanently acquiesce. We regard it as essential that we should be able to build any type of ship in the Royal Yards—if for no other reason, for the purpose of exercising some check on the prices quoted by private contractors. But in deciding where to build these particular four ships, we had certain immediate considerations to face which, in our opinion, after the most careful inquiry, have left us no alternative but to put them all out to tender. The first consideration was that of urgency. To lengthen the slips at Devonport and Portsmouth would take, in the one case, twenty, and, in the other, twenty-four months, working night and day. Our replacement programme has already been postponed to the utmost limit. To delay two of the ships for the best part of two years further would be taking risks for which the Admiralty could not make itself responsible. The second consideration was that of economy. The

lengthening of the Devonport slip would cost about £350,000; of the Portsmouth slip, £650,000. That expense—or so much less as falling prices may enable us to save in the future—will have to be incurred eventually. But to spend that £1,000,000 on enlarging Government slips, when at least six private slips are there ready and waiting for the work, does not seem to me a form of capital expenditure, which, however desirable in itself, can be justified at this juncture.

Finally, there is the consideration of employment. It is true these ships will give the same employment, from the point of view of the nation as a whole, wherever they are built. But, undoubtedly, the Government has a special responsibility to the great dockyard centres which depend upon it, and which have little or no alternative employment to look to. Even from that point of view, however, we should not be justified at this moment in stopping or postponing the work of building smaller ships or carrying on major repairs in order to effect these structural alterations. I can only repeat that we do intend, as soon as the financial situation allows, to bring the Royal Dockyards up to date in their capacity to build the biggest ships, and, meanwhile, we shall certainly do our best to keep them fully and efficiently employed. There will inevitably have to be further reductions in personnel from the present figures, but we hope in the course of the coming year to reach a condition of stability at figures approximately at the average pre-War level.

There is one matter on which the Committee will naturally wish for some information before I conclude, and that is the extent to which the whole problem of the future naval security of the British Empire has been considered at the present meeting of the Imperial Cabinet, and the conclusions to which that consideration has led. In dealing with that question, the Prime Ministers of the Empire have had to keep in view, not only the great problems of naval strategy considered by themselves, but the constitutional issues involved in Imperial co-operation and the still wider issues of international relations. The outcome of these deliberations was embodied at a meeting of the Prime Ministers of the Empire on July 27, in the following resolution:

NAVAL DEFENCE.

"That, while recognising the necessity of co-operation among the various portions of the Empire to provide such naval defence as may prove to be essential for security, and, while holding that equality with the naval strength of any other Power is a minimum standard for that purpose, this Conference is of opinion that the method and extent of such co-operation are matters for the final determination of the several Parliaments concerned, and that any recommendation thereon should be deferred until after the coming Conference on Disarmament."

That Resolution will, I venture to think, be regarded in future years as an important landmark, alike in the history of British naval policy and of the development of Imperial co-operation. It deals, of course, with the development of the future, and does not directly affect the policy embodied in the Vote now before the Committee. That policy, I can only repeat, has been based on the most anxious regard for economy and the most scrupulous care to avoid the suggestion that we are giving any justification or pretext for a renewed race in armaments. We are wedded to no mere verbal or arithmetical formula. But we are resolved not to let down the Navy, upon which our Empire, our prosperity, and our freedom have been founded, and by which alone they can endure.

# ABSTRACT OF NAVY ESTIMATES FOR 1921–1922.

| Votes. | | Estimates for 1921–1922. Gross Estimate. | Estimates for 1921–1922. Net Estimate. | Estimates, 1920-1921.† Net Estimate. |
|---|---|---|---|---|
| | I.—NUMBERS. | | Total Numbers. | Total numbers. |
| A. | Total number of Officers, Seamen, Boys, Coastguard, and Royal Marines | 123,700* | 123,700* | 136,000 |
| | II.—EFFECTIVE SERVICES. | £ | £ | £ |
| 1 | Wages, etc., of Officers, Seamen, and Boys, Coastguard, Royal Marines, and Mercantile Officers and Men | 18,390,800 | 18,314,000 | 21,164,000 |
| 2 | Victualling and Clothing for the Navy | 9,980,685 | 7,821,000 | 8,734,500 |
| 3 | Medical Establishments and Services | 733,392 | 720,500 | 708,500 |
| 4 | Civilians employed on Fleet Services | 394,050 | 389,000 | 612,800 |
| 5 | Educational Services | 508,355 | 465,500 | 458,500 |
| 6 | Scientific Services | 533,477 | 449,000 | 304,600 |
| 7 | Royal Naval Reserves | 581,765 | 580,600 | 449,800 |
| 8 | Shipbuilding, Repairs, Maintenance, etc.: | | | |
| | Section I.—*Personnel* | 11,648,969 | 11,618,600 | 12,063,200 |
| | Section II.—*Matériel* | 17,946,500 | 11,896,500 | 7,321,700 |
| | Section III.—Contract Work | 6,310,775 | 6,270,200 | 11,788,600 |
| 9 | Naval Armaments | 6,769,317 | 6,726,000 | 7,908,400 |
| 10 | Works, Buildings, and Repairs at Home and Abroad | 5,896,600 | 5,836,600 | 5,154,000 |
| 11 | Miscellaneous Effective Services | 2,777,090 | 2,725,000 | 4,306,500 |
| 12 | Admiralty Office | 1,756,737 | 1,752,800 | 1,928,700 |
| | Total Effective Services £ | 84,228,512 | 75,565,300 | 82,903,800 |
| | III.—NON-EFFECTIVE SERVICES. | | | |
| 13 | Half-Pay and Retired Pay | 2,122,848 | 2,093,500 | 2,430,000 |
| 14 | Naval and Marine Pensions, Gratuities, and Compassionate Allowances | 4,018,408 | 4,003,500 | 4,658,500 |
| 15 | Civil Superannuation, Compensation Allowances, and Gratuities | 817,101 | 816,700 | 880,000 |
| | Total Non-Effective Services £ | 6,958,357 | 6,913,700 | 7,968,500 |
| | GRAND TOTAL £ | 91,186,869 | 82,479,000 | 90,872,000† |

NET DECREASE . . . . . £8,393,300

NOTE.—The decrease on Gross Expenditure is £14,096,412.

* Maximum for the year, viz., on April 1, 1921. This number will be reduced to 121,700 as soon as practicable.
† Including Supplementary Estimate, December 7, 1920 (Parliamentary Paper No. 228).

LEE OF FAREHAM.
BEATTY.
H. F. OLIVER.
F. L. FIELD.

ALGERNON BOYLE.
O. DE B. BROCK.
A. E. M. CHATFIELD.
ONSLOW.

ADMIRALTY,
*March* 4, 1921.

JAMES CRAIG
O. MURRAY } Secretaries.

## STATEMENT SHOWING THE NUMBERS BORNE, THE EXPENDITURE ON NAVAL SERVICES FOR THE YEARS 1912–1913 TO 1919–1920, AND THE ESTIMATES FOR 1920–1921 AND 1921–1922.

| Year. | Vote A. — Average numbers borne. | Vote 1. — Wages, &c., of Officers, &c. | Vote 2. — Victualling and Clothing. | Vote 3. — Medical Establishments, &c. | Vote 4. — Martial Law. | Vote 5. — Educational Services. | Vote 6. — Scientific Services. | Vote 7. — Royal Naval Reserves. | Vote 8. — Shipbuilding, Repairs, Maintenance, &c. Section I. Personnel. | Vote 8. Section II. Matériel. | Vote 8. Section III. Contract Work. | Vote 9. — Naval Armaments. | Vote 10. — Works. | Vote 11. — Miscellaneous. | Vote 12. — Admiralty Office. | Vote 13. — Half Pay &c. | Vote 14. — Naval, &c., Pensions. | Vote 15. — Civil Superannuation, &c. | Balances Irrecoverable. | Total Expenditure. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ | £ |
| 1912–13 | 136,443 | 7,720,886 | 2,841,949 | 279,011 | 3,459 | 146,646 | 72,205 | 406,084 | 3,753,340 | 5,845,052 | 12,620,100 | 4,365,953 | 2,990,839 | 556,199 | 431,336 | 971,752 | 1,517,636 | 406,962 | 3,760 | 44,933,169 |
| 1913–14 | 142,960 | 8,262,203 | 3,034,246 | 281,382 | 3,640 | 156,468 | 53,375 | 440,028 | 4,128,108 | 6,746,714 | 13,217,129 | 4,747,829 | 3,520,026 | 734,491 | 460,221 | 990,233 | 1,562,093 | 392,223 | 2,212 | 48,732,621 |
| | | | | | Civilians employed on Fleet Services. (a) | | | | | | | | | | | | | | | |
| 1914–15 | 199,451 | 13,637,330 | 7,411,627 | 436,589 | 176,977 | 161,766 | 87,090 | 446,784 | 5,646,932 | 22,211,040 | 30,298,730 | 9,666,218 | 3,659,847 | 5,907,731 | 583,167 | 878,045 | 1,674,160 | 389,914 | 27,915 | 103,301,862 |
| 1915–16 | 297,008 | 24,321,519 | 10,796,024 | 578,703 | 444,907 | 171,610 | 108,535 | 755,201 | 7,868,812 | 44,778,970 | 64,513,255 | 25,649,203 | 5,710,782 | 16,321,128 | 851,066 | 717,519 | 1,730,117 | 400,161 | 17,085 | 205,733,597 |
| 1916–17 | 349,578 | 29,399,358 | 11,173,592 | 713,525 | 517,209 | 201,497 | 110,478 | 863,943 | 8,943,491 | 40,952,653 | 53,982,842 | 36,742,534 | 6,694,878 | 15,460,001 | 1,024,108 | 713,621 | 1,944,003 | 388,509 | 50,976 | 209,877,218 |
| 1917–18 | 406,977 | 37,559,536 | 13,481,159 | 792,569 | 561,308 | 210,243 | 152,160 | 874,930 | 12,660,160 | 36,494,694 | 70,609,055 | 34,177,359 | 6,556,769 | 9,193,802 | 1,454,835 | 709,227 | 1,446,247 | 413,746 | 41,092 | 227,388,891 |
| 1918–19 | 381,311 | 46,373,511 | 24,219,351 | 1,158,287 | 491,270 | 247,922 | 262,886 | 871,970 | 15,037,763 | 59,128,675 | 94,248,874 | 64,866,784 | 10,928,241 | 9,357,532 | 1,985,894 | 704,914 | 3,733,778 | 445,485 | 28,090 | 334,091,227 |
| 1919–20 | 176,087 | 32,385,306 | 8,823,106 | 733,046 | 556,778 | 401,864 | 364,832 | 458,044 | 12,426,177 | Credit:— *785,986* | 48,348,933 | 14,441,835 | 5,595,608 | 11,118,631 | 2,042,715 | 1,176,937 | 15,133,064 | 802,279 | 60,875 | 154,084,044 |
| 1920–21 (Estimate, including Supplementary Estimate). | 136,000(b) | 21,164,000 | 8,734,500 | 708,500 | 612,800 | 458,500 | 304,600 | 449,800 | 12,063,200 | 7,321,700 | 11,788,600 | 7,908,400 | 5,154,000 | 4,306,500 | 1,928,700 | 2,430,000 | 4,658,500 | 880,000 | — | 90,872,300 |
| 1921–22 (Estimate) | 123,700(c) | 18,314,000 | 7,821,000 | 720,500 | 389,000 | 465,500 | 449,000 | 580,600 | 11,618,600 | 11,896,500 | 6,270,200 | 6,726,000 | 5,836,600 | 2,725,000 | 1,752,800 | 2,093,500 | 4,003,500 | 816,700 | — | 82,479,000 |

***Note.*—The figures under Vote 9 include the cost of Naval Aviation Services from the year 1916–1917 to the year 1919–1920 inclusive.**

**(a) Replacing "Martial Law," transferred to Vote 11 in 1914-1915.**

**(b) Maximum number voted. The estimated average for the year is 124,700.**

**(c) Maximum for the year, viz. on April 1, 1921. This number will be reduced to 121,700 as soon as practicable.**

# UNITED STATES NAVY.

## APPROPRIATION ACT, 1922 (*i.e.* July 1, 1921, to June 30, 1922).

(The figures given within brackets are from the Appropriation Bill of 1921).

| | Dollars. | Dollars. |
|---|---|---|
| Miscellaneous Pay, Naval Aviation, Marine Schools, etc., Bureau Charges (exclusive of Construction and Repair and Increase of the Navy) . . . . | | 226,156,747 (266,516,316) |
| Principal sums included in the above— | | |
| Miscellaneous Pay . . . . . | 3,500,000 | |
| Naval Aviation . . . . . | 13,413,431 | |
| BUREAU OF NAVIGATION— | | |
| Transport and Recruiting . . | 3,500,000 | |
| Naval Training Stations . . . | 1,631,805 | |
| BUREAU OF ORDNANCE— | | |
| Ordnance and Ordnance Stores . | 14,000,000 | |
| BUREAU OF YARDS AND DOCKS— | | |
| Maintenance . . . . . . | 7,500,000 | |
| Public Works . . . . . . | 7,032,000 | |
| BUREAU OF MEDICINE AND SURGERY— | | |
| Medical Department . . . . | 2,920,000 | |
| BUREAU OF SUPPLIES AND ACCOUNTS— | | |
| Pay of the Navy . . . . . | 137,815,503 | |
| Provisions . . . . . . | 21,925,922 | |
| Maintenance . . . . . . | 9,000,000 | |
| Freight, Fuel, Transportation, and Bureau of Construction and Repair . . . . . . . | | 67,098,884 (76,013,907) |
| Principal sums included— | | |
| Freight . . . . . . . | 4,000,000 | |
| Fuel and Transportation . . . | 17,500,000 | |
| BUREAU OF CONSTRUCTION AND REPAIR— | | |
| Construction and Repair of Vessels . | 22,500,000 | |
| BUREAU OF ENGINEERING— | | |
| Engineering, Repairs, etc. . . | 20,500,000 | |
| NAVAL ACADEMY— | | |
| Total, exclusive of Public Works . | 2,273,846 | |
| Marine Corps Pay, etc. . . . . . . . | | 27,700,342 (28,876,046) |
| INCREASE OF THE NAVY— | | 90,000,000 (113,000,000) |
| Construction and Machinery . . . . . | 53,000,000 (52,000,000) | |
| Torpedo Boats . . . . . . . | 4,000,000 (12,000,000) | |
| Armour and Armament . . . . . . | 33,000,000 (49,000,000) | |
| | | 410,955,973 (484,406,269) |

With respect to the appropriation of 90,000,000 dollars for the Increase of the Navy, that is for continuing the programme, the Act provides that no part of this appropriation shall be expended except on vessels now being constructed.

Sec. 8 of the Act provides for the creation of a Bureau of Aeronautics, under a Chief, from the active list of the Navy or the Marine Corps, who within a year shall qualify as an aircraft pilot or observer. There is to be an Assistant Chief, and arrangements are made for the transfer of officers and men to this branch of the Service.

Sec. 9 relates to the Washington Conference on naval reduction.

# APPENDIX TO MERCHANT SHIPPING SECTION.

# MERCHANT SHIPPING OF THE WORLD.

## NUMBER AND TONNAGE OF MERCHANT VESSELS LAUNCHED.*

| | 1900. | | 1910. | | 1912. | | 1913. | | 1919. | | 1920. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. |
| United Kingdom | 692 | 1,442,471 | 500 | 1,143,169 | 712 | 1,738,514 | 688 | 1,932,153 | 612 | 1,620,442 | 618 | 2,055,624 |
| British Dominions | 40 | 9,563 | 60 | 26,343 | 84 | 34,790 | 91 | 48,339 | 263 | 358,728 | 103 | 203,644 |
| United States | 235 | 333,527 | 195 | 331,318 | 174 | 284,223 | 205 | 276,448 | 1051 | 4,075,385 | 509 | 2,476,253 |
| Austria-Hungary | 12 | 14,889 | 8 | 14,304 | 12 | 38,821 | 17 | 61,757 | — | — | — | — |
| Denmark | 17 | 11,060 | 18 | 12,154 | 22 | 26,103 | 31 | 40,932 | 46 | 37,766 | 30 | 60,669 |
| Holland | 61 | 45,074 | 105 | 70,945 | 112 | 99,439 | 95 | 104,296 | 100 | 137,086 | 99 | 183,149 |
| France | 66 | 116,858 | 55 | 80,751 | 80 | 110,734 | 89 | 176,095 | 34 | 32,663 | 50 | 93,449 |
| Germany | 93 | 204,731 | 117 | 159,303 | 165 | 375,317 | 162 | 465,226 | No returns. | | No returns. | |
| Italy | 36 | 67,522 | 21 | 23,019 | 27 | 25,196 | 38 | 50,356 | 32 | 82,713 | 82 | 133,190 |
| Japan | 3 | 4,543 | 70 | 30,215 | 168 | 57,755 | 152 | 64,664 | 133 | 611,883 | 140 | 456,642 |
| Norway | 42 | 32,751 | 64 | 36,931 | 89 | 50,255 | 74 | 50,637 | 82 | 57,578 | 30 | 38,855 |
| Russia | 37 | 7,240 | 14 | 4,395 | 24 | 15,171 | 10 | 3,300 | — | — | — | — |
| Spain | 2 | 2,572 | 1 | 3,234 | 12 | 4,260 | 12 | 8,488 | 41 | 52,609 | 13 | 45,950 |
| Sweden | 19 | 5,735 | 17 | 8,904 | 22 | 13,968 | 25 | 18,524 | 53 | 50,971 | 46 | 63,823 |
| Other Countries | 9 | 5,627 | 32 | 12,868 | 16 | 27,223 | 61 | 31,667 | 36 | 26,725 | 39 | 50,418 |
| World's Total | 1364 | 2,304,163 | 1277 | 1,957,853 | 1719 | 2,901,769 | 1750 | 3,332,882 | 2483 | 7,144,549 | 1759 | 5,861,666 |

* Figures given include all steamers and sailing vessels of 100 gross tons and upwards.

MERCHANT VESSELS UNDER CONSTRUCTION.*

| | 1900. | | 1910. | | 1912. | | 1913. | | 1919. | | 1920. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. |
| United Kingdom | 443 | 1,269,919 | 363 | 1,131,503 | 542 | 1,970,065 | 513 | 1,956,606 | 757 | 2,994,249 | 921 | 3,708,916 |
| British Dominions | — | — | 16 | 12,231 | 21 | 14,194 | 38 | 38,785 | 113 | 251,480 | 74 | 186,655 |
| United States | 54 | 197,888 | 59 | 96,289 | 83 | 236,185 | 66 | 147,597 | 647 | 2,966,515 | 235 | 1,310,312 |
| Austria-Hungary | 4 | 13,700 | 13 | 38,320 | 15 | 73,250 | 16 | 63,300 | — | — | — | — |
| Denmark | 8 | 10,703 | 8 | 9,625 | 13 | 20,897 | 12 | 25,362 | 56 | 100,335 | 57 | 121,279 |
| Holland | 24 | 32,447 | 24 | 47,620 | 61 | 114,811 | 41 | 126,867 | 126 | 328,338 | 174 | 450,964 |
| France | 41 | 121,158 | 24 | 109,106 | 32 | 175,588 | 39 | 229,020 | 65 | 216,775 | 104 | 397,969 |
| Germany | 70 | 203,984 | 63 | 160,932 | 92 | 542,519 | 102 | 544,682 | No returns. | | No returns. | |
| Italy | 30 | 87,720 | 6 | 15,505 | 21 | 52,370 | 23 | 53,809 | 125 | 314,547 | 159 | 363,784 |
| Japan | 7 | 18,034 | 28 | 33,058 | 36 | 45,703 | 14 | 47,797 | 64 | 309,474 | 59 | 248,513 |
| Norway | 22 | 19,680 | 27 | 20,920 | 43 | 27,851 | 49 | 42,614 | 61 | 92,719 | 59 | 83,928 |
| Russia | — | — | — | — | 12 | 13,978 | 1 | 5,620 | — | — | — | — |
| Spain | 2 | 2,500 | 1 | 3,838 | 4 | 6,909 | 3 | 6,855 | 28 | 107,463 | 27 | 89,840 |
| Sweden | 7 | 3,315 | 7 | 11,585 | 16 | 16,515 | 18 | 18,400 | 67 | 110,765 | 64 | 122,578 |
| Other Countries | 12 | 11,190 | 14 | 8,580 | 14 | 27,901 | 19 | 23,829 | 29 | 68,703 | 47 | 95,540 |
| World's Total | 724 | 1,992,238 | 653 | 1,699,112 | 1005 | 3,338,736 | 954 | 3,331,143 | 2138 | 7,861,363 | 1980 | 7,179,778 |

* The figures give the number and aggregate gross tonnage of steamers, motor ships, and sailing vessels under construction on December 31st of each year.

ANNUAL MERCHANT SHIPPING LOSSES OF THE WORLD.*

| | 1900. | | | 1910. | | | 1912. | | | 1913. | | | 1919. | | | 1920. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. | Tonnage. | % of Tonnage owned. | No. | Tonnage. | % of Tonnage owned. | No. | Tonnage. | % of Tonnage owned. | No. | Tonnage. | % of Tonnage owned. | No. | Tonnage. | % of Tonnage owned. | No. | Tonnage. | % of Tonnage owned. |
| United Kingdom | 218 | 245,645 | 1·86 | 129 | 222,069 | 1·27 | 137 | 262,156 | 1·44 | 113 | 199,453 | 1·07 | 99 | 151,653 | ·92 | 99 | 131,481 | ·72 |
| British Dominions | 45 | 25,467 | 2·50 | 44 | 27,858 | 1·86 | 46 | 19,398 | 1·17 | 37 | 20,091 | 1·16 | 89 | 52,539 | 2·56 | 64 | 29,022 | 1·39 |
| United States | 99 | 56,154 | 2·76 | 75 | 50,996 | 1·82 | 64 | 39,796 | 1·40 | 91 | 71,469 | 2·38 | 115 | 150,272 | 1·15 | 108 | 159,694 | 1·16 |
| Austria-Hungary | 5 | 2,146 | ·52 | 2 | 3,210 | ·41 | 1 | 2,227 | ·25 | 3 | 5,536 | ·55 | — | — | — | — | — | — |
| Denmark | 29 | 13,136 | 2·53 | 11 | 9,506 | 1·29 | 14 | 7,503 | ·99 | 13 | 6,583 | ·86 | 15 | 5,295 | ·75 | 22 | 6,646 | ·88 |
| Holland | 8 | 5,026 | ·95 | 4 | 8,121 | ·80 | 5 | 4,317 | ·38 | 4 | 1,340 | ·10 | 23 | 11,550 | ·73 | 15 | 4,417 | ·25 |
| France | 49 | 51,525 | 3·82 | 31 | 20,789 | 1·10 | 29 | 21,687 | 1·06 | 30 | 34,506 | 1·57 | 34 | 40,420 | 1·81 | 40 | 63,866 | 1·97 |
| Germany | 58 | 50,578 | 1·91 | 39 | 44,233 | 1·02 | 28 | 45,860 | ·99 | 31 | 56,379 | 1·11 | 50 | 24,167 | — | 19 | 10,280 | 1·58 |
| Italy | 47 | 36,577 | 3·72 | 17 | 18,534 | 1·40 | 25 | 27,877 | 1·99 | 26 | 26,881 | 1·77 | 8 | 3,096 | ·23 | 10 | 13,287 | ·59 |
| Japan | — | — | — | 22 | 21,505 | † | 33 | 27,553 | † | 25 | 25,514 | † | 38 | 41,418 | † | 29 | 41,988 | † |
| Norway | 152 | 98,867 | 6·0 | 73 | 67,971 | 3·37 | 63 | 59,939 | 2·61 | 61 | 60,648 | 2·47 | 41 | 44,132 | 2·37 | 42 | 52,648 | 2·37 |
| Russia | 32 | 13,698 | 1·9 | 31 | 19,441 | 2·19 | 17 | 6,666 | ·71 | 29 | 23,894 | 2·45 | 4 | 4,771 | ·88 | 7 | 15,529 | 2·91 |
| Spain | 19 | 23,815 | 3·36 | 15 | 17,599 | 2·30 | 9 | 12,883 | 1·66 | 13 | 15,928 | 1·89 | 16 | 9,752 | 1·30 | 18 | 14,826 | 1·49 |
| Sweden | 40 | 14,651 | 2·3 | 31 | 15,260 | 1·66 | 30 | 12,700 | 1·31 | 30 | 17,327 | 1·65 | 38 | 29,021 | 2·92 | 23 | 23,026 | 2·15 |
| Other Countries | 52 | 40,897 | — | 38 | 44,444 | — | 50 | 40,812 | — | 36 | 42,686 | — | 65 | 54,719 | — | 65 | 78,893 | — |
| World's Total | 848 | 677,182 | — | 562 | 591,536 | — | 551 | 591,324 | — | 542 | 608,235 | — | 635 | 622,805 | | 561 | 645,608 | — |

* Figures refer to steam and sailing vessels of 100 gross tons and over totally lost, condemned, etc. The tonnage given is gross for steamers and net for sailing ships.
† Japanese sailing vessels not included.

## LARGEST STEAMERS OF THE WORLD.

| Gross Tonnage. | Name. | Speed (knots). | Built. | Flag. | Owners. | Registered Dimensions.‡ Length. | Breadth. | Depth. |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ft. | ft. | ft. |
| 56,000 | Majestic (*ex*-Bismarck)* | — | Building | British | White Star | 912·0 | 100·0 | 57·1 |
| 54,282 | Leviathan (*ex*-Vaterland)* | 23 | 1914 | United States | U.S. Navy Department | 907·6 | 100·3 | 58·2 |
| 52,022 | Berengaria (*ex*-Imperator)* | 22 | 1912 | British | Cunard | 882·9 | 98·3 | 57·1 |
| 46,359 | Olympic | 23 | 1911 | British | White Star | 852·5 | 92·5 | 59·5 |
| 45,647 | Aquitania | 24 | 1914 | British | Cunard | 868·7 | 97·0 | 49·7 |
| 35,000 | Columbus* | — | 1913 | † | † | 750·0 | 83·0 | 48·9 |
| 34,568 | Paris | 22 | 1921 | French | Cie. Gén. Transatlantique | 734·9 | 85·2 | 59·1 |
| 30,704 | Mauretania | 25 | 1907 | British | Cunard | 762·2 | 88·0 | 57·1 |
| 25,570 | George Washington* | 19 | 1908 | United States | U.S. Navy Department | 699·1 | 78·2 | 50·1 |
| 25,000 | Caracciolo | 18 | 1921 | Italian | Nav. Gen. Italiana | — | — | — |
| 24,581 | Kaiserin Auguste Victoria* | 18 | 1905 | British | Canadian Pacific Ocean Services | 677·5 | 77·3 | 50·2 |
| 24,547 | Belgic | 18½ | 1917 | British | International Nav. Co., Ltd. | 670·4 | 78·4 | 44·7 |
| 24,541 | Adriatic | 18½ | 1906 | British | White Star | 709·2 | 75·5 | 52·6 |
| 24,149 | Rotterdam | 17 | 1908 | Dutch | Nederl. Amerik Stoomv. Maats | 650·5 | 77·4 | 43·5 |
| 23,876 | Baltic | 17 | 1904 | British | White Star | 709·2 | 75·6 | 52·6 |
| 23,666 | France | 24 | 1912 | French | Cie. Gén. Transatlantique | 689·2 | 75·6 | 48·5 |
| 22,622 | America | 17½ | 1905 | United States | U.S. Navy Department | 668·8 | 74·3 | 47·8 |
| 22,000 | Empress of Canada | 18 | 1920 | British | Canadian Pacific Ocean Services | 627·0 | 77·9 | 31·7 |
| 22,000 | Duilio | 18½ | 1917 | Italian | Nav. Gen. Italiana | 601·4 | 75·9 | 50·1 |
| 21,500 | Giulio Cesare | 18½ | 1919 | Italian | " " " | 601·4 | 76·0 | 51·0 |
| 21,477 | Tirpitz* | — | 1914 | British | † | 590·0 | 75·2 | 41·5 |
| 21,073 | Cedric | 17 | 1903 | British | White Star | 680·9 | 75·3 | 44·1 |
| 20,904 | Celtic | 17 | 1901 | British | " " | 680·9 | 75·3 | 44·1 |
| 20,602 | Minnesota | 13 | 1904 | United States | Atlantic Transport Coy. of West Virginia | 622·0 | 73·5 | 41·5 |
| 20,597 | Cap Polonio* | 18 | 1914 | British | Shipping Controller | 637·7 | 72·3 | 39·5 |
| 20,200 | Brabantia* (*ex*-William O'Swald) | 17 | 1914 | Dutch | Koninkl. Hollandsche Lloyd | 596·0 | 72·3 | 40·2 |

* *Ex*-German ships.

† The flag and ownership of these *ex*-German vessels is not yet decided.

‡ The registered dimensions are measured as follows: Length from fore part of stem under bowsprit to aft side of head of stern post: breadth is taken to outside of plating; depth from top of beam of tonnage deck to ceiling at midships. If there is no ceiling it is measured to the tank top. If there are more than two decks the tonnage deck is the second deck counting from below.

GENERAL PARTICULARS OF LARGE SHIPS OF VARIOUS NATIONALITIES.

| Name of Ship | Aquitania. | Mauretania. | Olympic. | Paris. | Leviathan (formerly Vaterland). | Berengaria (formerly Imperator). |
|---|---|---|---|---|---|---|
| Name of Builders | John Brown & Co., Ltd., Clydebank | Swan, Hunter & Wigham Richardson, Ltd., Wallsend-on-Tyne | Harland & Wolff, Ltd., Belfast | Soc. des Chantiers et Ateliers de St. Nazaire | Blohm & Voss, Hamburg | Vulcan Co., Hamburg |
| Name of Owners or Managers | Cunard Co. | Cunard Co. | White Star Line | Cie. Générale Transatlantique | U.S. Navy Department | Cunard Co. |
| Year when built | 1914 | 1907 | 1911 | 1921 | 1914 | 1912 |
| Length over all | 901 ft. 6 ins. | 790 ft. | 883 ft. | 764 ft. 6 ins. | 950 ft. | 905 ft. |
| Length between perpendiculars (or moulded) | 865 ft. | 760 ft. | 850 ft. | 735 ft. 4 ins. | — | 880 ft. |
| Breadth | 96 ft. 6 ins. | 88 ft. | 92 ft. | 85 ft. 4 ins. | 100 ft. | 98 ft. |
| Depth (moulded) | 64 ft. 6 ins. | 60 ft. 6 ins. | 64 ft. 3 ins. | 68 ft. 2 ins. | 63 ft. | 62 ft. |
| Gross Tonnage | 45,647 | 30,704 | 46,359 | 34,568 | 54,282 | 52,022 |
| Draught | 35 ft. 3¾ ins. | 36 ft. 2½ ins. | 34 ft. 7 ins. | 31 ft. 2 ins. | 38 ft. 6 ins. | 35 ft. 6 ins. |
| Displacement (tons) | 51,700 | 41,590 | — | 36,700 | 63,100 | 57,000 |
| Number of Passengers— | | | | | | |
| First Class | 597 | 602 | 817 | 563 | 672 † | 700 |
| Second Class | 614 | 430 | 510 | 460 | 535 | 600 |
| Third Class | 2000 (and 52 servants) | 780 | 1216 | 2210 § | 2392 ‡ | 2690 |
| Machinery Makers | John Brown & Co., Ltd. | Wallsend Slipway and Engineering Co., Ltd. | Harland & Wolff, Ltd., Belfast | Soc. des Chantiers et Ateliers de St. Nazaire. | Blohm & Voss, Hamburg | Vulcan Co., Hamburg |
| Type of Engines | Steam Turbines driving Four Screws | Steam Turbines driving Four Screws | Reciprocating with Turbine on Centre Shaft | Steam Turbines driving Four Screws | Turbines | Steam Turbines driving Four Screws |
| Number of Cranks | — | — | 8 | — | — | — |
| Diameters of Cylinders | — | — | Two 54 ins.; two 84 ins.; and four 97 ins. | — | — | — |
| Stroke of Pistons | — | — | 75 ins. | — | — | — |
| Revolutions per Minute | 180 | 200 | Reciprocating engines, 77; Turbine, 165 | 230 | 180–190 | 185 |
| Total Indicated or Shaft Horse-power | 60,000 | 75,000 | 51,000 | 44,000 | — | 76,250 |
| Number and Type of Boilers | 21 Cylindrical (double ended) | 25 Cylindrical (23 double-ended, 2 single-ended) | 29 Cylindrical (24 double-ended, 5 single-ended) | 15 Cylindrical (double-ended) | 46 Water Tube | 46 Water Tube |
| Number of Furnaces | 168 (now fitted for oil burning) | 192 | 159 (now fitted for oil burning) | 120 (oil-fired) | 138 | 46 |
| Steam Pressure (lb. per sq. in.) | 195 | 195 | 215 | 213 | 235 | 235 |
| Total Heating Surface (sq. ft.) | 138,595 | 159,000 | 142,454 | 97,600 | 210,440 | 203,009 |
| Total Grate Area (sq. ft.) | 3541 | 4060 | 3428 | 2550 | 3843 | 3763 |
| System of Draught | Howden's | Howden's | Natural | Howden's | Howden's | Howden's |
| Speed on Service (knots) | 23·5 | 25·5 * | 22·75 | 20·5 | 22·5 | 22·5 |

* Note.—This figure is the mean speed attained for 27 consecutive runs across the North Atlantic in one year covering a total distance of 77,500 nautical miles. The highest mean speed from Queenstown to New York was 26·06 knots. † 80 Berths for Servants and 110 Pullman Berths in addition. ‡ Including 1542 Fourth Class Passengers. § Including 1118 Emigrants.

## FASTEST STEAMERS OF THE WORLD.

| Speed (knots). | Name. | Gross Tonnage. | Date built. | Flag. | Owners. | L.* (ft.). | B.* (ft.). | D.* (ft.). |
|---|---|---|---|---|---|---|---|---|
| 25 | Mauretania | 30,704 | 1907 | British | Cunard | 762·2 | 88·0 | 57·1 |
| 24 and under 25. | Anglia | 3,460 | 1920 | ,, | L. & N. W. Rly. | 380·5 | 45·2 | 17·2 |
| | Aquitania | 45,647 | 1914 | ,, | Cunard. | 868·7 | 97·0 | 49·7 |
| | Hibernia | 3,458 | 1920 | ,, | L. & N. W. Rly. | 380·6 | 45·2 | 17·2 |
| | Paris | 1,774 | 1913 | ,, | L. B. & S. C. Rly. | 293·5 | 35·6 | 15·2 |
| | Jan Breydel | 1,767 | 1909 | Belgian | Belgian Government | 348·0 | 40·0 | 23·2 |
| | Pieter de Coninck | 1,767 | 1910 | ,, | ,, | 348·0 | 40·0 | 23·2 |
| | Princesse Elisabeth | 1,747 | 1905 | ,, | ,, | 357·0 | 40·0 | 23·2 |
| | Stad Antwerpen | 1,384 | 1913 | ,, | ,, | 300·0 | 36·0 | 22·9 |
| | Ville de Liege | 1,366 | 1913 | ,, | ,, | 300·0 | 36·0 | 22·9 |
| 23 and under 24. | France | 23,666 | 1912 | French | Cie. Gén. Trans-Atlantique | 689·2 | 75·6 | 48·5 |
| | Munster | 2,646 | 1897 | British | City of Dublin Steam Packet Co. | 360·0 | 41·5 | 27·3 |
| | Olympic | 46,359 | 1911 | ,, | White Star | 852·5 | 92·5 | 59·3 |
| | Ulster | 2,641 | 1896 | ,, | City of Dublin Steam Packet Co. | 360·0 | 41·5 | 27·5 |
| | Viking | 1,957 | 1905 | ,, | Isle of Man St. Packet Co. | 350·4 | 42·0 | 16·1 |
| | Newhaven | 1,656 | 1911 | French | Chemins de Fer de l'État Français and the L. B. & S. C. Rly. | 292·0 | 34·6 | 22·1 |
| 22 and under 23. | Rouen | 1,656 | 1912 | ,, | | 292·0 | 34·6 | 22·1 |
| | Berengaria | 52,022 | 1912 | British | Cunard | 882·9 | 98·3 | 57·1 |
| | Biarritz | 2,495 | 1915 | ,, | S. E. & C. Rly. | 341·2 | 42·1 | 24·0 |
| | Brighton | 1,129 | 1903 | ,, | L. B. & S. C. Rly. | 273·6 | 34·2 | 14·1 |
| | Dieppe | 1,228 | 1905 | ,, | ,, | 273·5 | 34·8 | 13·8 |
| | Maid of Orleans | 2,384 | 1918 | ,, | S. E. & C. Rly. | 341·1 | 42·1 | 16·0 |
| | Manxman | 2,048 | 1904 | ,, | Isle of Man St. Packet Co. | 334·0 | 43·1 | 17·3 |
| | Mona's Isle | 1,688 | 1905 | ,, | ,, | 311·2 | 40·1 | 15·8 |
| | Snaefell | 1,713 | 1906 | ,, | ,, | 315·0 | 39·6 | 15·7 |
| | St. Andrew | 2,528 | 1908 | ,, | Fishguard and Rosslare Railways and Harbours Co. | 351·1 | 41·1 | 16·5 |
| | St. David | 2,457 | 1906 | ,, | ,, | 350·8 | 41·1 | 16·5 |
| | St. George | 2,535 | 1906 | ,, | Gt. Eastern Rly. | 352·0 | 41·1 | 16·2 |
| | St. Patrick | 2,456 | 1906 | ,, | Fishguard and Rosslare Railways and Harbours Co. | 350·8 | 41·1 | 16·5 |
| | Wahine | 4,436 | 1913 | ,, | Union S.S. Co. of New Zealand, Ltd. | 375·0 | 52·2 | 25·6 |
| | Paris | 34,568 | 1921 | French | Cie. Gén. Trans-Atlantique | 734·9 | 85·2 | 59·1 |
| | Princesse Clémentine | 1,474 | 1896 | Belgian | Belgian Government | 341·3 | 37·8 | 14·2 |
| | Prinses Juliana | 2,908 | 1920 | Dutch | Stoomv. Maats. "Zeeland" | 350·4 | 42·7 | 23·9 |
| 21 and under 22. | Oranje Nassau | 2,885 | 1909 | ,, | ,, | 350·0 | 42·7 | 16·4 |
| | Antwerp | 2,957 | 1920 | British | Gt. Eastern Rly. | 321·6 | 43·1 | 17·9 |
| | Archangel | 2,448 | 1910 | ,, | ,, | 330·8 | 48·2 | 17·8 |
| | Arundel | 1,068 | 1900 | ,, | L. B. & S. C. Rly. | 269·1 | 34·1 | 14·1 |
| | Bruges | 2,949 | 1920 | ,, | Gt. Eastern Ry. | 321·6 | 43·1 | 17·9 |
| | Curraghmore | 1,587 | 1919 | ,, | L. & N. W. Rly. | 307·1 | 40·1 | 14·5 |
| | Empress | 1,695 | 1907 | ,, | S. E. & C. Rly. | 311·3 | 40·1 | 15·8 |
| | Empress of Asia | 16,909 | 1913 | ,, | Canadian Pacific Ocean Services, Ltd. | 570·1 | 68·2 | 42·0 |
| | Empress of Russia | 16,810 | 1913 | ,, | ,, | 570·2 | 68·2 | 42·0 |
| | Engadine | 1,676 | 1911 | ,, | S. E. & C. Rly. | 316·0 | 41·1 | 15·8 |
| | Invicta | 1,680 | 1905 | ,, | ,, | 311·2 | 40·1 | 15·8 |
| | King Orry | 1,877 | 1913 | ,, | Isle of Man St. Packet Co. | 300·0 | 43·1 | 15·9 |
| | Lady Moyra | 519 | 1905 | ,, | W. H. Tucker & Co., Ltd. | 245·0 | 29·0 | 9·7 |
| | Princess Patricia | 1,158 | 1902 | ,, | Canadian Pacific Rly. Co. | 270·0 | 32·1 | 11·6 |
| | Riviera | 1,675 | 1911 | ,, | S. E. & C. Rly. | 316·0 | 41·1 | 15·8 |
| | St. Denis | 2,435 | 1908 | ,, | Gt. Eastern Rly. | 331·0 | 43·2 | 17·8 |
| | Victoria | 1,689 | 1907 | ,, | ,, | 311·0 | 40·1 | 15·8 |
| | La Lorraine | 11,372 | 1900 | French | Cie. Gén. Trans-Atlantique | 563·1 | 60·0 | 35·9 |

* Registered dimensions; see note on p. 426.

## FASTEST STEAMERS OF THE WORLD—*continued.*

| Speed (knots). | Name. | Gross Tonnage. | Date built. | Flag. | Owners. | L.* (ft.). | B.* (ft.) | D.* (ft.). |
|---|---|---|---|---|---|---|---|---|
| 21 and under 22. | La Savoie | 11,168 | 1900 | French | Cie. Gén. Trans-Atlantique | 563·1 | 60·0 | 35·9 |
| | Venezia | 979 | 1906 | Italian | D. Tripcovich | 275·0 | 32·1 | 10·2 |
| | Leviathan | 54,282 | 1914 | U.S. | U.S. Govt. (Navy Dept.) | 907·6 | 100·3 | 58·2 |
| | Von Steuben | 14,901 | 1901 | ,, | ,, | 637·1 | 66·3 | 39·3 |
| 20 and under 21. | Antrim | 1,954 | 1904 | British | Midland Rly. | 330·9 | 42·2 | 17·2 |
| | Britannia | 459 | 1896 | ,, | P. and A. Campbell, Ltd. | 230·0 | 26·6 | 9·6 |
| | Cambria | 420 | 1895 | ,, | ,, | 225·0 | 26·1 | 9·4 |
| | Devonia | 520 | 1905 | ,, | ,, | 245·0 | 29·0 | 9·7 |
| | Duke of Argyll | 2,036 | 1909 | ,, | L. & Y. and L. & N. W. Rlys. | 330·9 | 41·1 | 17·1 |
| | Duke of Cumberland | 2,036 | 1909 | ,, | ,, | 330·7 | 41·1 | 17·1 |
| | Empress of France | 18,481 | 1913 | ,, | Allan Line | 571·4 | 72·4 | 41·7 |
| | Kaiser | 1,916 | 1905 | ,, | — | 303·1 | 38·4 | 13·3 |
| | Londonderry | 1,968 | 1904 | ,, | Midland Rly. | 330·6 | 42·1 | 17·1 |
| | Loongana | 2,448 | 1904 | ,, | Union S.S. Co. of New Zealand, Ltd. | 300·3 | 43·1 | 23·3 |
| | Maori | 3,412 | 1907 | ,, | ,, | 350·5 | 47·2 | 24·7 |
| | Queen Alexandra | 785 | 1912 | ,, | J. Williamson & Co. | 270·3 | 32·1 | 11·0 |
| | Westward Ho | 438 | 1894 | ,, | P. and A. Campbell, Ltd. | 225·0 | 26·1 | 9·5 |
| | Rapide | 1,195 | 1895 | Belgian | Belgian Government | 300·0 | 38·0 | 13·6 |
| | Charles Roux | 4,104 | 1907 | French | Cie. Gén. Trans-Atlantique | 385·5 | 45·6 | 26·1 |
| | Lutetia | 14,654 | 1913 | ,, | Cie. de Nav. Sud Atlantique | 579·0 | 64·1 | 36·7 |
| | Massilia | 15,000 | 1916 | ,, | ,, | 574·0 | 64·0 | 40·2 |
| | Prins Hendrik | 1,968 | 1895 | Dutch | Stoomv. Maats. "Zeeland" | 320·0 | 35·8 | 16·0 |
| | Ausonia | 10,000 | 1915 | Italian | Soc. Italiana di Servizi Marittimi | 491·0 | 61·7 | 39·2 |
| | Città di Catania | 3,262 | 1910 | ,, | Italian Government | 363·5 | 42·1 | 18·8 |
| | Città di Siracusa | 3,497 | 1910 | ,, | ,, | 363·5 | 42·1 | 18·5 |
| | Esperia | 11,393 | 1918 | ,, | Soc. Italiana di Servizi Marittimi | 492·1 | 61·7 | 34·1 |
| | San Giusto | 8,606 | 1890 | ,, | Cosulich Soc. Triestina di Nav. | 518·6 | 58·3 | 25·6 |
| | Agamemnon | 19,361 | 1902 | U.S. | U.S. Govt. (Navy Dept.) | 684·3 | 72·3 | 40·2 |
| | City of Detroit III. | 6,061 | 1912 | ,, | Detroit and Cleveland Navigation Co. | 455·8 | 55·5 | 22·5 |
| | Mount Vernon | 18,372 | 1906 | ,, | U.S. Govt. (Navy Dept.) | 685·4 | 72·2 | 40·5 |
| | Midland | 1,535 | 1895 | ,, | Norfolk and Washington Steamboat Co. | 260·0 | 46·0 | 14·1 |
| | Northland | 2,055 | 1911 | ,, | ,, | 291·2 | 51·0 | 18·0 |
| | Southland | 2,081 | 1908 | ,, | ,, | 291·2 | 51·0 | 16·1 |
| | Tacoma | 836 | 1913 | ,, | J. Green | 209·4 | 30·0 | 17·6 |

* Registered dimensions; see note on p. 426.

## NUMBERS OF MERCHANT VESSELS OF VARIOUS SPEEDS.

| Speed. | Number. 1910. | 1920. | 1921. | Speed. | Number. 1910. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| 25 knots and over | — | 1 | 1 | 16½ knots | 45 | 45 | 45 |
| 24 ,, and under 25 | — | 9 | 10 | 16 ,, | 126 | 120 | 124 |
| 23 ,, ,, 24 | — | 10 | 6 | 15½ ,, | 47 | 42 | 35 |
| 22 ,, ,, 23 | — | 15 | 17 | 15 ,, | 215 | 178 | 183 |
| 21 ,, ,, 22 | — | 20 | 21 | 14½ ,, | 85 | 70 | 76 |
| 20 ,, ,, 21 | 105* | 30 | 30 | 14 ,, | 276 | 281 | 276 |
| 19 ,, ,, 20 | 42 | 27 | 26 | 13½ ,, | 138 | 156 | 163 |
| 18½ knots | 24 | 18 | 20 | 13 ,, | 462 | 403 | 434 |
| 18 ,, | 60 | 56 | 52 | 12½ ,, | 206 | 166 | 148 |
| 17½ ,, | 48 | 42 | 42 | 12 ,, | 732 | 698 | 739 |
| 17 ,, | 83 | 76 | 80 | | | | |

* This figure includes all merchant steamers of 20 knots and over in existence in 1910.

PARTICULARS OF FASTEST VOYAGES ON PRINCIPAL PASSENGER SERVICES.

| Name of vessel. | Owners. | Date of Voyage. | Ports between which Voyage was made. | Total distance. (Sea miles) | Time taken. | Average speed (Knots). | Best days run. (Knots). | Remarks. |
|---|---|---|---|---|---|---|---|---|
| Mauretania . . | Cunard Steam Ship Co., Ltd. | Sept., 1910 | Liverpool and New York | 2,813½* | 4 days, 10 hours, 41 mins. | 26·4 | — | * The distance given is between Daunts Rock and Ambrose Channel Light Vessel, the points between which the time was taken. On a voyage in January, 1911, the Mauretania attained a speed of 27·04 knots for one day, and the best day's run on the same voyage was 676 knots. Her record average speed for the whole voyage is 26·06 knots. |
| Olympic . . . | White Star Line | Nov. 7-13, 1920 | New York and Southampton | 3,001 (ocean passage) | 5 days, 13 hours, 10 mins. | 22·53 | 534 | |
| Empress of France | Canadian Pacific Ocean Services, Ltd. | Aug. 25-31, 1920 | Liverpool and Quebec | 2,633 | 5 days, 20 hours, 6 mins. | 18·8 | 484 | |
| China . . . . | Peninsular and Oriental Steam Navigation Co. | Sept. 26 to Oct. 14, 1919 | London and Bombay | 6,258 | 17 days 20 hours.† | 15·3 | — | |
| Orduna . . . | Pacific Steam Navigation Co. | Jan, 27 to April 15, 1921 | Liverpool and Valparaiso *via* Magellan Straits and home *via* Panama Canal to France and Liverpool | 17,585 | 77 days, 12 hours, 15 mins. | 13·7 | 367 ‡ | |
| Paris . . . . | L.B. & S.C. Railway | July 14, 1913 | Newhaven and Dieppe | 65 | 2 hours, 35 mins., 37 secs. | 25·07 | — | |
| Maid of Orleans . | S.E. & C. Railway | March 25, 1921 | Dover and Calais | 20 | 50 mins. | 24 | — | † Record sea transit to Bombay, but not record speed as vessel did not have to deviate to Marseilles. |
| St. George . . | Gt. Western Railway | July 6, 1910 | Fishguard and Rosslare | 54 | 2 hours, 28 mins. | 21·9 | — | |
| Lorina . . . . | L. & S.W. Railway | Sept. 4, 1920 | Jersey and Southampton | 130 | 6 hours, 34 mins. | 19·8 | — | ‡ Between Lisbon and Rio de Janeiro. |

## NUMBERS OF VESSELS CLASSED BY VARIOUS CLASSIFICATION SOCIETIES.*

| Society. | | 1900. | 1910. | 1912. | 1913. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|---|
| Lloyds Register | | 9290 | 10,302 | 10,445 | 10,466 | 9175* | 9924 | 10,154 |
| British Corporation | | 477 | 675 | 802 | 876 | 1002 | 1021 | 1190 |
| American Bureau of Shipping | Record of American and Foreign Shipping | 1284 | 1139 | 894 | 846 | 926 | 1581 | 2216 |
| | Gt. Lakes Register | — | 609 | 537 | 572 | 442 | 393 | 392 |
| Bureau Veritas | | 5122 | 4626 | 5046 | 5165 | 5706 | 5666 | 6387 |
| Norske Veritas | | 2076 | 1560 | 1505 | 1604 | 955 | 1034 | 1109 |
| Registro Navale Italiano | | 1116 | 1263 | 1052 | 1442 | 699 | 975 | 1280 |
| Germanischer Lloyd | | 1761 | 2672 | 2793 | 2848 | — | — | — |
| Veritas Adriatico | | 1107 | 1041 | 1111 | 1146 | 516 | 376 | 471 |

* Many vessels, of course, are not exclusively classed in one Register.

## "EXPORTS" OF NEW SHIPS FROM THE UNITED KINGDOM.

### Ships not Registered as British, with their Machinery.

| Year. | War Vessels. | Steam Ships (other than War Vessels). Hulls and Fittings. | Steam Ships (other than War Vessels). Machinery. | Sailing Ships (other than War Vessels) including Boats. | Total of New Ships. |
|---|---|---|---|---|---|
| | £ | £ | £ | £ | £ |
| 1903 | 74,480 | 2,798,737 | 1,222,108 | 188,504 | 4,283,829 |
| 1904 | 388,600 | 2,570,835 | 1,164,779 | 330,937 | 4,455,151 |
| 1905 | 50,000 | 3,693,422 | 1,516,183 | 171,693 | 5,431,298 |
| 1906 | 2,800,000 | 3,973,873 | 1,668,592 | 201,706 | 8,644,171 |
| 1907 | 554,700 | 6,586,449 | 2,550,702 | 326,262 | 10,018,113 |
| 1908 | 1,879,994 | 5,902,428 | 2,505,280 | 189,773 | 10,567,475 |
| 1909 | 247,000 | 3,698,556 | 1,819,618 | 161,940 | 5,927,114 |
| 1910 | 4,894,500 | 2,553,427 | 1,209,119 | 113,158 | 8,770,204 |
| 1911 | 25,000 | 3,745,349 | 1,632,402 | 259,564 | 5,663,115 |
| 1912 | 765,000 | 4,243,308 | 1,750,351 | 268,503 | 7,027,162 |
| 1913 | 2,617,100 | 5,867,179 | 2,336,509 | 205,742 | 11,026,530 |
| 1914 | 308,385 | 4,716,226 | 1,784,900 | 123,043 | 6,932,554 |
| 1915 | — | 1,170,606 | 472,597 | 49,548 | 1,692,661 |
| 1916 | 20,000 | 754,372 | 481,703 | 34,510 | 1,290,585 |
| 1917 | — | 706,084 | 347,354 | 33,869 | 1,087,307 |
| 1918 | — | 778,525 | 229,292 | 39,517 | 1,047,334 |
| 1919 | — | 1,703,961 | 505,652 | 118,718 | 2,328,331 |

NUMBER AND GROSS TONNAGE OF THE VESSELS OF 100 TONS GROSS AND UPWARDS (STEAM, SAIL, AND MOTOR) BELONGING TO EACH OF THE SEVERAL COUNTRIES OF THE WORLD, AS RECORDED IN LLOYD'S REGISTER.

| Flag. | June, 1910. | | June, 1913. | | June, 1915. | |
|---|---|---|---|---|---|---|
| | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. |
| British — U.K. | 9,417 | 17,516,479 | 9,214 | 18,696,237 | 9,285 | 19,541,368 |
| British — Brit. Dom. | 2,078 | 1,495,815 | 2,073 | 1,735,306 | 2,068 | 1,732,700 |
| British — Total | 11,495 | 19,012,294 | 11,287 | 20,431,543 | 11,353 | 21,274,068 |
| American — Sea | 2,774 | 2,761,605 | 2,696 | 2,998,457 | 2,580 | 3,522,933 |
| American — Lakes | 606 | 2,256,619 | 627 | 2,382,690 | 600 | 2,323,397 |
| American — Philippine Islands | 89 | 40,454 | 77 | 46,489 | 69 | 46,309 |
| American — Total | 3,469 | 5,058,678 | 3,400 | 5,427,636 | 3,249 | 5,892,639 |
| Argentine | 267 | 163,421 | 308 | 214,835 | 317 | 222,533 |
| Austro-Hungarian | 369 | 779,029 | 427 | 1,011,414 | 433 | 1,018,210 |
| Belgian | 165 | 299,638 | 172 | 304,386 | 164 | 276,427 |
| Brazilian | 383 | 251,753 | 459 | 329,637 | 443 | 317,414 |
| Chilian | 139 | 151,218 | 131 | 139,792 | 123 | 128,592 |
| Chinese | 68 | 90,420 | 66 | 86,690 | 81 | 98,079 |
| Cuban | 60 | 59,445 | 59 | 61,536 | 48 | 37,882 |
| Danish | 863 | 736,562 | 811 | 762,054 | 835 | 854,996 |
| Dutch | 628 | 1,015,193 | 759 | 1,309,849 | 809 | 1,522,547 |
| Esthonian | — | — | — | — | — | — |
| Finnish | — | — | — | — | — | — |
| French | 1,465 | 1,882,280 | 1,552 | 2,201,164 | 1,539 | 2,285,728 |
| German | 2,178 | 4,333,186 | 2,321 | 5,082,061 | 2,166 | 4,706,027 |
| Greek | 408 | 527,581 | 442 | 722,782 | 510 | 908,725 |
| Italian | 1,080 | 1,320,653 | 1,114 | 1,521,942 | 1,177 | 1,736,545 |
| Japanese | 851 | 1,149,222 | 1,037 | 1,500,014 | 1,155 | 1,826,068 |
| Latvian | — | — | — | — | — | — |
| Norwegian | 2,065 | 2,014,533 | 2,191 | 2,457,890 | 2,174 | 2,529,188 |
| Peruvian | 57 | 31,587 | 60 | 45,514 | 66 | 53,749 |
| Portuguese | 190 | 110,183 | 208 | 120,579 | 206 | 122,726 |
| Roumanian | 23 | 31,973 | 33 | 45,408 | 34 | 54,603 |
| Russian | 1,241 | 887,325 | 1,216 | 974,178 | 1,256 | 1,054,762 |
| Spanish | 579 | 765,460 | 607 | 840,995 | 642 | 899,204 |
| Swedish | 1,472 | 918,079 | 1,436 | 1,047,270 | 1,462 | 1,122,883 |
| Turkish | 332 | 175,869 | 272 | 157,298 | 212 | 133,162 |
| Uruguayan | 54 | 63,412 | 65 | 75,531 | 52 | 47,740 |
| Other Countries and flag not recorded | 157 | 85,771 | 158 | 98,115 | 214 | 137,272 |
| Total | 30,058 | 41,914,765 | 30,591 | 46,970,113 | 30,720 | 49,261,769 |

NUMBER AND GROSS TONNAGE OF THE VESSELS OF 100 TONS GROSS AND UPWARDS (STEAM, SAIL, AND MOTOR) BELONGING TO EACH OF THE SEVERAL COUNTRIES OF THE WORLD, AS RECORDED IN LLOYD'S REGISTER—*continued.*

| Flag. | | June, 1919. | | June, 1920. | | June, 1921. | |
|---|---|---|---|---|---|---|---|
| | | No. | Gross Tonnage. | No. | Gross Tonnage. | No. | Gross Tonnage. |
| British | U.K. | 7,964 | 16,555,471 | 8,561 | 18,330,424 | 9,034 | 19,571,554 |
| | Brit. Dom. | 2,141 | 2,052,404 | 2,270 | 2,252,228 | 2,399 | 2,499,244 |
| | Total | 10,105 | 18,607,875 | 10,831 | 20,582,652 | 11,433 | 22,070,798 |
| American | Sea | 4,350 | 10,782,170 | 4,889 | 13,789,874 | 4,958 | 14,697,088 |
| | Lakes | 506 | 2,257,786 | 492 | 2,207,429 | 494 | 2,254,930 |
| | Philippine Islands | 73 | 51,817 | 76 | 51,986 | 99 | 73,984 |
| | Total | 4,929 | 13,091,773 | 5,475 | 16,049,289 | 5,551 | 17,026,002 |
| Argentine | | 215 | 154,441 | 198 | 150,023 | 209 | 167,154 |
| Austro-Hungarian | | 339 | 714,617 | — | — | — | — |
| Belgian | | 152 | 313,276 | 213 | 415,112 | 256 | 551,031 |
| Brazilian | | 428 | 512,675 | 400 | 497,860 | 402 | 499,325 |
| Chilian | | 114 | 101,647 | 112 | 103,788 | 124 | 113,447 |
| Chinese | | 102 | 132,515 | 102 | 142,834 | 122 | 163,037 |
| Cuban | | 51 | 47,295 | 58 | 53,439 | 59 | 58,553 |
| Danish | | 645 | 702,436 | 745 | 803,411 | 798 | 964,464 |
| Dutch | | 931 | 1,591,911 | 987 | 1,793,396 | 1,069 | 2,225,787 |
| Esthonian | | — | — | — | — | 90 | 41,183 |
| Finnish | | 338 | 180,962 | 312 | 166,689 | 330 | 198,352 |
| French | | 1,440 | 2,233,631 | 1,758 | 3,245,194 | 2,044 | 3,652,249 |
| German | | 1,768 | 3,503,380 | 1,138 | 672,671 | 1,255 | 717,450 |
| Greek | | 312 | 323,796 | 405 | 530,261 | 362 | 599,929 |
| Italian | | 858 | 1,370,097 | 1,115 | 2,242,393 | 1,271 | 2,650,573 |
| Japanese | | 1,418 | 2,325,266 | 1,940 | 2,995,878 | 2,033 | 3,354,806 |
| Latvian | | — | — | — | — | 99 | 53,842 |
| Norwegian | | 1,629 | 1,857,829 | 1,777 | 2,219,388 | 1,889 | 2,584,058 |
| Peruvian | | 63 | 79,342 | 69 | 88,962 | 68 | 87,167 |
| Portuguese | | 227 | 261,212 | 249 | 275,665 | 284 | 296,847 |
| Roumanian | | 35 | 63,792 | 39 | 74,540 | 37 | 73,973 |
| Russian | | 618 | 541,005 | 613 | 534,547 | 465 | 412,459 |
| Spanish | | 576 | 750,611 | 749 | 997,030 | 828 | 1,165,541 |
| Swedish | | 1,263 | 992,611 | 1,297 | 1,072,925 | 1,353 | 1,160,211 |
| Turkish | | 161 | 116,249 | — | — | — | — |
| Uruguayan | | 43 | 44,499 | 47 | 63,837 | 54 | 85,886 |
| Other Countries and flag not recorded | | 495 | 304,530 | 989 | 1,542,272 | 721 | 1,001,029 |
| Total | | 29,255 | 50,919,273 | 31,595 | 57,314,065 | 33,206 | 61,974,653 |

## PERSONS EMPLOYED IN VESSELS OF THE UNITED KINGDOM.*

| Trades in which Employed. | Year. | Sailing Vessels. Persons Employed (including Foreigners).† | Steam Vessels. Persons Employed (including Foreigners).† | Total Persons Employed (including Foreigners).† |
|---|---|---|---|---|
| In the Home Trade. | 1904 | 19,964 | 45,451 | 65,415 |
| | 1905 | 19,346 | 46,366 | 65,712 |
| | 1906 | 19,127 | 48,986 | 68,113 |
| | 1907 | 18,389 | 52,858 | 71,247 |
| | 1908 | 17,795 | 55,014 | 72,809 |
| | 1909 | 17,279 | 55,395 | 72,674 |
| | 1910 | 16,344 | 56,721 | 73,065 |
| | 1911 ‡ | 13,419 | 56,855 | 70,274 |
| | 1912 | 12,045 | 58,577 | 70,622 |
| | 1913 | 11,326 | 59,754 | 71,080 |
| | 1914 * | 10,084 | 58,588 | 68,672 |
| Partly in the Home and partly in the Foreign Trade | 1904 | 441 | 5,585 | 6,026 |
| | 1905 | 739 | 7,701 | 8,440 |
| | 1906 | 439 | 8,586 | 9,025 |
| | 1907 | 320 | 5,362 | 5,682 |
| | 1908 | 332 | 6,022 | 6,354 |
| | 1909 | 283 | 8,957 | 9,240 |
| | 1910 | 282 | 11,250 | 11,532 |
| | 1911 | 282 | 11,487 | 11,769 |
| | 1912 | 233 | 9,991 | 10,224 |
| | 1913 | 222 | 13,081 | 13,303 |
| | 1914 * | 224 | 12,298 | 12,522 |
| In the Foreign Trade | 1904 | 19,469 | 168,579 | 188,048 |
| | 1905 | 17,482 | 172,052 | 189,534 |
| | 1906 | 16,056 | 177,597 | 193,653 |
| | 1907 | 14,350 | 185,867 | 200,217 |
| | 1908 | 12,408 | 184,150 | 196,558 |
| | 1909 | 10,772 | 181,621 | 192,393 |
| | 1910 | 9,207 | 182,502 | 191,709 |
| | 1911 | 7,027 | 192,230 | 199,257 |
| | 1912 | 5,505 | 200,455 | 205,960 |
| | 1913 | 4,618 | 203,056 | 207,674 |
| | 1914 * | 3,786 | 210,672 | 214,458 |
| Total | 1904 | 39,874 | 219,615 | 259,489 |
| | 1905 | 37,567 | 226,119 | 263,686 |
| | 1906 | 35,622 | 235,169 | 270,791 |
| | 1907 | 33,059 | 244,087 | 277,146 |
| | 1908 | 30,535 | 245,186 | 275,721 |
| | 1909 | 28,334 | 245,793 | 274,307 |
| | 1910 | 25,833 | 250,473 | 276,306 |
| | 1911 | 20,728 | 260,572 | 281,300 |
| | 1912 | 17,783 | 269,023 | 286,806 |
| | 1913 | 16,166 | 275,891 | 292,057 |
| | 1914 * | 14,094 | 281,558 | 295,652 |

NOTES.—This return includes vessels belonging to the Isle of Man and the Channel Islands.
The number of persons employed in the year is the sum of the number of persons forming the first crew of each vessel employed during the year.
The Home Trade includes vessels trading or going within the following limits, viz.: the United Kingdom, the Isle of Man, the Channel Islands, and the Continent of Europe between the River Elbe and Brest.
The Foreign Trade includes vessels trading or going beyond the above limits.
Some vessels known to be trading abroad are omitted from the return owing to the fact that information as to the numbers of their crews could not be obtained.

* Statistics for the years since 1914 are not available.

† Including masters, pilots, and lascars.

‡ Vessels employed on rivers and going beyond smooth-water limits as defined in the regulations regarding passenger vessels, but not beyond *partially* smooth-water limits, have been excluded from the Employment Returns since the end of 1910. 781 sailing vessels of 34,976 tons, and 86 steam vessels of 3809 tons, which would have been included in the totals for 1911 had the basis remained unchanged, have thus been excluded.

## BRITISH AND FOREIGN SAILORS AND LASCARS EMPLOYED IN VESSELS OF THE UNITED KINGDOM.*

| | Sailing Vessels. | | | Steam Vessels. | | | Total. | | |
|---|---|---|---|---|---|---|---|---|---|
| Years. | British. | Foreign. | Lascars.* | British. | Foreign. | Lascars.* | British. | Foreign. | Lascars.* |
| 1903 | 33,067 | 9,141 | 30 | 143,453 | 31,255 | 40,991 | 176,520 | 40,396 | 41,021 |
| 1904 | 31,496 | 8,368 | 10 | 145,479 | 31,464 | 42,672 | 176,975 | 39,832 | 42,682 |
| 1905 | 30,213 | 7,323 | 31 | 150,279 | 32,388 | 43,452 | 180,492 | 39,711 | 43,483 |
| 1906 | 29,148 | 6,444 | 30 | 159,192 | 31,640 | 44,337 | 188,340 | 38,084 | 44,367 |
| 1907 | 27,382 | 5,669 | 8 | 167,466 | 32,025 | 44,596 | 194,848 | 37,694 | 44,604 |
| 1908 | 25,677 | 4,848 | 10 | 171,157 | 29,887 | 44,142 | 196,834 | 34,735 | 44,152 |
| 1909 | 24,407 | 3,927 | — | 174,067 | 27,946 | 43,960 | 198,474 | 31,873 | 43,960 |
| 1910 | 22,488 | 3,345 | — | 179,422 | 27,117 | 43,934 | 210,910 | 30,462 | 43,934 |
| 1911 | 18,346 | 2,382 | — | 186,719 | 28,401 | 45,452 | 205,065 | 30,783 | 45,452 |
| 1912 | 15,920 | 1,863 | — | 192,715 | 29,097 | 47,211 | 208,635 | 30,960 | 47,211 |
| 1913 | 14,329 | 1,837 | — | 198,241 | 30,802 | 46,848 | 212,570 | 32,639 | 46,848 |
| 1914† | 12,495 | 1,588 | 11 | 200,145 | 29,808 | 51,605 | 212,640 | 31,396 | 51,616 |

* Under the heading "Lascars" are included Asiatics and East Africans, whether British subjects or Foreigners, employed on vessels trading between India and this country, or entirely in Asiatic or American waters, and serving under Agreements which terminate in Asia.

† Statistics for the years since 1914 are not available.

## PAY IN THE MERCHANT SERVICE.—Monthly Rates.

### *Officers.*

| Rating. | Cargo Steamers. 1914. | Cargo Steamers. 1919.‡ |
|---|---|---|
| | £ s. £ s. | £ s. £ s. |
| First Mates | 12 5 to 14 5 | 23 0 to 32 0 |
| Second Mates | 9 5 ,, 12 15 | 21 10 ,, 25 10 |
| Third Mates | 7 10 ,, 10 10 | 19 0 ,, 20 10 |
| Boatswains | 6 5 ,, 6 10 | 16 0 ,, 18 0 |
| Carpenters | 7 0 ,, 7 10 | 17 0 ,, 21 0 |
| First Engineers | 16 15 ,, 24 0 | 27 0 ,, 41 0 |
| Second Engineers | 12 5 ,, 14 15 | 23 0 ,, 32 0 |
| Third Engineers | 8 15 ,, 11 15 | 21 10 ,, 25 10 |

| Rating. | Passenger Steamers. 1914. | Passenger Steamers. 1919.‡ |
|---|---|---|
| | £ s. £ s. | £ s. £ s. |
| First Mates | 17 0 to 19 15 | 28 0 to 35 0 |
| Second Mates | 11 0 ,, 16 5 | 24 10 ,, 28 0 |
| Third Mates | 9 0 ,, 13 10 | 21 0 ,, 24 10 |
| Boatswains | 6 0 ,, 7 5 | 16 0 ,, 18 0 |
| Carpenters | 7 0 ,, 8 5 | 17 0 ,, 21 0 |
| First Engineers | 22 5 ,, 26 5 | 34 0 ,, 40 0 |
| Second Engineers | 14 0 ,, 17 0 | 28 0 ,, 35 0 |
| Third Engineers | 12 0 ,, 14 10 | 24 10 ,, 28 0 |

### *Men.*

| Rating. | 1914. | 1919.‡ |
|---|---|---|
| | £ s. £ s. | £ s. |
| British Seamen | 5 0 to 5 10 | 14 10 (including £3 War bonus) |
| British Firemen | 5 10 ,, 6 0 | 15 0 (including £3 War bonus) |

‡ The 1919 figures are the National Maritime Board standard rates of pay for Seamen and Firemen, and are in approximate agreement with the scale for officers. The standard rates in 1921 are £2 per month lower than the 1919 N.M.B. scales. This applies to both officers and men.

## FLUCTUATIONS IN THE PRICE OF A NEW, READY 7,500-TON CARGO STEAMER.

| Period. | £. |
|---|---|
| 1898 (Sept.) | 48,500 |
| 1905 (June) | 36,500 |
| 1908 (June) | **36,000** |
| 1910 (Jan.) | 39,000 |
| 1912 (Dec.) | 58,000 |
| 1914 (June) | 42,500 |
| 1914 (Dec.) | 55,000 |
| 1915 (Jan.) | 60,000 |
| 1915 (June) | 82,500 |
| 1915 (Sept.) | 93,500 |
| 1916 (Jan.) | 125,000 |
| 1916 (June | 180,000 |
| 1917 (Jan.) | 187,500 |
| 1918 (Jan.) | 165,000 |
| 1918 (June) | 180,500 |
| 1919 (Jan.) | 169,000 |
| 1920 (Jan.) | **232,000** |
| 1920 (June) | 180,000 |
| 1921 (Jan.) | 105,000 |
| 1921 (June) | 63,750 |

Compiled from "Fairplay," July 7, 1921.

NOTE.—The highest and lowest prices are given in heavy type.

## IMPORTANT DATES IN THE DEVELOPMENT OF MARINE PROPELLING MACHINERY.

| — | Approximate Date of Introduction in the United Kingdom. | | | |
|---|---|---|---|---|
| | Merchant. | | Naval. | |
| Compound engines | — | 1860 | — | 1865 |
| Triple-expansion engines | — | 1880 | — | 1885 |
| Quadruple-expansion engines | — | 1890 | Not fitted | — |
| Cylindrical boilers | — | 1862 | — | 1869 |
| Water-tube boilers | Cross-channel | 1911 | Destroyers | 1893 |
| | Ocean liners | 1914 | Battleships | 1897 |
| Direct turbines | Cross-channel | 1901 | Destroyers | 1898 |
| | Ocean liners | 1905 | Light cruisers | 1904 |
| | | | Battleships | 1906 |
| Combination engines and and turbines | Intermediate liner | 1908 | (For cruising only) | 1902 |
| Geared turbines | Single-reduction | 1911 | Single-reduction | 1913 |
| | Double-reduction | 1916 | Not fitted | — |
| Electric propulsion | First attempts | 1904 | Not fitted | — |
| | Modern plant | 1912 | — | — |
| Oil fuel burning | First attempts | 1870 | Coal and oil— | |
| | | | Destroyers | 1902 |
| | | | Battleships | 1904 |
| | Modern plant | 1892 | Oil alone— | |
| | | | Destroyers | 1910 |
| | | | Battleships | 1913 |
| Heavy oil engines | First attempts | 1904 | Tender | 1914 |
| | Modern plant | 1910 | Submarines | 1908 |

PROGRESS IN MARINE MACHINERY—ATLANTIC LINERS.

| | 1881. | 1888. | 1893. | 1899. | 1903. | 1907. | 1914. |
|---|---|---|---|---|---|---|---|
| **Ship Dimensions—** | | | | | | | |
| Length | 500′ 0″ | 528′ 0″ | 600′ 0″ | 685′ 0″ | 678′ 0″ | 760′ 0″ | 865′ 0″ |
| Beam | 50′ 0″ | 63′ 0″ | 65′ 0″ | 68′ 5″ | 72′ 0″ | 87′ 6″ | 96′ 6″ |
| **Perfomance—** | | | | | | | |
| Speed in Knots | 18·0 | 20·1 | 22·0 | 20·7 | 23·3 | 26·0 | 23·5 |
| Horse Power | 10,680 | 18,500 | 30,000 | 27,000 | 40,000 | 72,500 | 60,000 |
| **Engines—** | | | | | | | |
| No. of Propellers | One | Two | Two | Two | Two | Four | Four |
| Type of Machinery | Vertical Compound | Vertical Triple Expansion | Vertical Triple Expansion | Vertical Triple Expansion | Vertical Quadruple Expansion | Steam Turbines | Steam Turbines |
| Cylinders on each shaft | 68″, 100″, 100″ by 72″ stroke | 45″, 71″, 113″ by 60″ stroke | 37″, 37″, 79″, 98″, 98″ by 69″ stroke | 47½″, 79″, 93″, 93″ by 72″ stroke | 37·4″, 37·4″, 49·2″, 49·2″, 74·8″, 74·8″, 112·2″, 112·2″ by 71″ stroke | — — | — — |
| Revolutions of Propeller | 64·2 | 86 | 81 | 78 | 80 | 180 | 180 |
| Piston Speed (f.p.m.) | 770 | 860 | 930 | 936 | 947 | — | — |
| Referred M.P. (lb. per sq. in.) | 29·1 | 35·3 | 35 | 35 | 35 | — | — |
| **Boilers—** | | | | | | | |
| No. and type | — Cylindrical | 9 double-ended Cylindrical | 12 double-ended Cylindrical | 15 double-ended Cylindrical | 12 double-ended & 7 single-ended Cylindrical | 23 double-ended & 2 single-ended Cylindrical | 21 double-ended Cylindrical |
| Working-pressure (lb. per sq. in.) | 100 | 150 | 165 | 192 | 225 | 195 | 195 |
| System of Draught | Natural Draught | Closed Stokehold | Natural Draught | Assisted Draught | Natural Draught | Howden's | Howden's |
| Heating Surface per H.P. | 3·3 sq. ft. | 2·75 sq. ft. | 2·73 sq. ft. | 2·77 sq. ft. | 2·68 sq. ft. | 2·19 sq. ft. | 2·31 sq. ft. |
| H.P. per sq. ft. of grate | 8·57 | 14·3 | 11·4 | 13·75 | 12·8 | 17·9 | 16·9 |
| Total Weight of Machinery "Steam up" | 1860 tons | 2516 tons | 4935 tons | 4414 tons | — | 9936 tons | 9302 tons |
| H.P. per ton of Machinery | 5·74 | 7·4 | 6·1 | 6·1 | — | 7·3 | 6·5 |
| Coal Consumption per H.P. hour | — | 1·7 lbs. | 1·6 lbs. | — | — | 1·4 lbs. | 1·3 lbs. |

## PROGRESS IN MARINE MACHINERY—INTERMEDIATE OCEAN LINERS.*

| Year | 1880. | 1892. | 1911. | 1914. | 1920. |
|---|---|---|---|---|---|
| Ship dimensions— | | | | | |
| Length | 400 ft. | 470 ft. | 520 ft. | 550 ft. | 550 ft. |
| Beam | 45 ft. | 53 ft. | 64 ft. | 66 ft. 6 in. | 66 ft. |
| Performance— | | | | | |
| Speed in knots | 12·5 | 12·5 | 14·5 | 16·5 | 17 |
| Horse-power | 3,000 I.H.P. | 3,500 I.H.P. | 7,500 I.H.P. | 11,000 S.H.P. | 11,000 S.H.P. |
| Engines— | | | | | |
| No. of propellers | One | Two | Two | Two | Two |
| Type of machinery | Vertical compound | Vertical triple-expansion | Vertical quadruple expansion | Geared steam turbines | Geared steam turbines |
| Dimensions of cylinders | 52-in., 96-in. by 66-in. | 22½-in., 36½-in., 60-in. by 48-in. | 26-in., 37-in., 53-in., 76-in. by 54-in. | Two H.P. and two L.P. turbines with single-reduction-gearing | Two H.P. and two L.P. turbines with double-reduction-gearing |
| Propeller (revs. per min.) | 61 | 80 | 82 | 133 | 85 |
| Piston speed (feet per min.) | 671 | 640 | 738 | Turbine revs. 1,650 | H.P. turbine, revs. 3,200; L.P. turbine, revs. 2,000 |
| Referred mean pressure | 20·5 | 32·0 | 37 | — | — |
| Condenser surface per H.P. | 1·85 | 1·6 | 0·84 | 0·80 | 0·62 |
| Boilers— | | | | | |
| No. and type | Two cylindrical | Two D.E. and one S.E. cylindrical | Five double-ended cylindrical | Five double-ended cylindrical | Five water-tube boilers, burning oil fuel (with superheaters) |
| Working pressure (lb. per sq. in.) | 90 | 170 | 210 | 210 | 250 |
| System of draught | Natural | Natural | Natural | Howden's forced draught | Oil-burning with forced draught |
| Heating surface per H.P. | 3·1 sq. ft. | 3·3 sq. ft. | 3·25 sq. ft. | 2·5 sq. ft. | 2·25 sq. ft. |
| H.P. per sq. feet of grate | 7·6 | 10·0 | 11·75 | 17·5 | — |
| Total weight of machinery "Steam up" | 685 tons | 795 tons | 1,750 tons | 1,800 tons | 1,210 tons |
| H.P. per ton of machinery | 4·35 | 4·4 | 4·25 | 6·1 | 9·1 |
| Coal consumption per H.P. hour | 2·375 lb. | 1·875 lb. | 1·55 lb. | 1·4 lb. | 0·875 lb. (Oil). |

* This and the two succeeding tables are from "Two Centuries of Shipbuilding by the Scotts at Greenock" (1920).

PROGRESS IN MARINE MACHINERY—CARGO STEAMERS.

| Year | 1877. | 1885. | 1911. | 1914. | 1920. |
|---|---|---|---|---|---|
| Ship dimensions— | | | | | |
| Length | 314 ft. | 320 ft. | 440 ft. | 450 ft. | 503 ft. |
| Beam | 35 ft. | 38 ft. | 52 ft. 6 in. | 56 ft. | 63 ft. |
| Performance— | | | | | |
| Speed in knots | 11·25 | 12·25 | 13·25 | 14·25 | 14·25 |
| Horse-power | 775 I.H.P. | 1,650 I.H.P. | 4,200 I.H.P. | 4,000–5,000 S.H.P. | 7,000 S.H.P. |
| Engines— | | | | | |
| No. of propellers | One | One | One | One | Two |
| Type of machinery | Tandem compound with flywheel | Triple-expansion | Triple-expansion | Steam turbines and single-reduction gearing; one H.P. and one L.P. turbine | Steam turbines and double-reduction gearing; two H.P. and two L.P. turbines |
| Propeller (revs. per min.) | 52 | 70 | 73 | 102 | 80 |
| Piston speed (feet per min.) | 450 | 560 | 750 | 1,350 revs. of turbines | H.P. turbines, 3,500 revs.; L.P. turbines, 2,500 revs. |
| Referred mean pressure | 23 | 31·5 | 35 | — | — |
| Condenser surface per H.P. | 2·17 | 1·83 | 1·5 | 1·18 | 1·12 |
| Boilers— | | | | | |
| No. and type | One-Oval ends and round middle portion | Two cylindrical | Two main cylindrical | Two cylindrical | Three cylindrical oil-fired boilers with superheaters |
| Working pressure (lb. per sq. in.) | 70 | 150 | 190 | 195 | 200 |
| System of draught | Natural | Natural | Forced draught | Howden's forced draught | Oil burning with forced draught |
| Heating surface per H.P. (sq. ft.) | 4·46 | 2·82 | 2·8 | 2·30 | 2·25 |
| H.P. per sq. ft. of grate | 7·6 | 10·4 | 16·25 | 20·0 | — |
| Weights— | | | | | |
| Weight of machinery | 200 | 340 | 900 | 930 | 1,100 |
| H.P. per ton of machinery | 3·87 | 4·85 | 4·67 | 6·45 | 6·35 |
| Coal consumption per H.P. hour | About 2·5 lb. | 1·95 lb. | 1·65 lb. | 1·45 lb. | 0·85 lb. (Oil). |

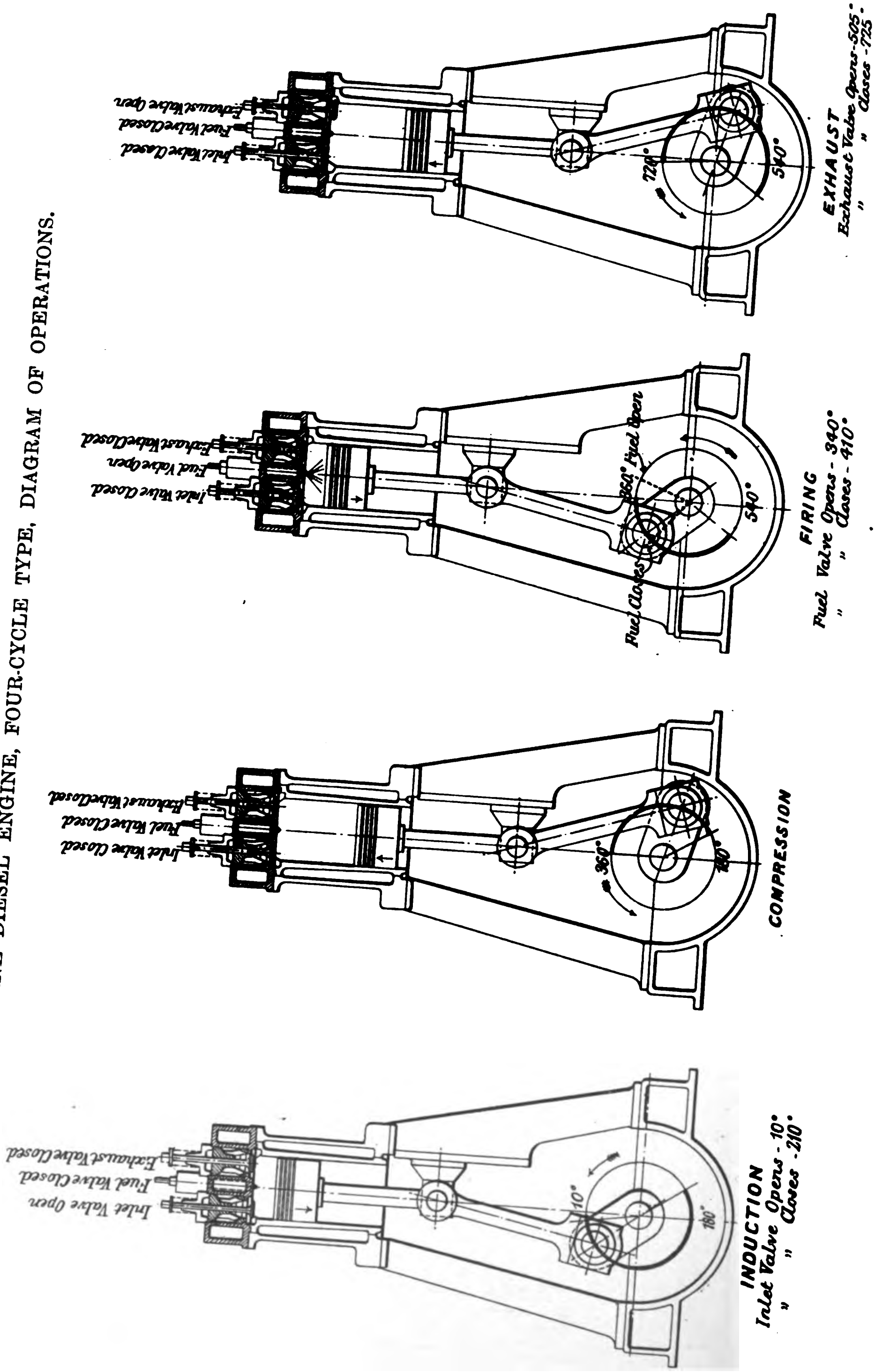
PROGRESS IN MARINE MACHINERY—CROSS-CHANNEL STEAMERS.

| Year | 1890. | 1898. | 1904. | 1910. | 1920. |
|---|---|---|---|---|---|
| Ship dimensions— | | | | | |
| Length | 300 ft. | 315 ft. | 330 ft. | 316 ft. | 302 ft. |
| Beam | 34 ft. 6 in. | 37 ft. | 42 ft. | 41 ft. | 35 ft. 6 in. |
| Performance— | | | | | |
| Speed in knots | 18 | 19·75 | 19·5 | 21·5 | 23·5 |
| Horse-power | 4,400 I.H.P. | 5,520 I.H.P. | 5,500 S.H.P. | 8,500 S.H.P. | 12,300 S.H.P. |
| Engines— | | | | | |
| No. of propellers | Two | Two | Three | Three | Two |
| Type of machinery | Three-cylinder triple-expansion | Four-cylinder triple-expansion | Direct steam turbines, one H.P. and two L.P. | Direct steam turbines, one H.P. and two L.P. | Geared steam turbines, two H.P. and two L.P. |
| Propeller (revs. per min.) | 130 | 165 | 550 | 625 | 435 |
| Piston speed (feet per min.) | 780 | 910 | Turbines, 550 revs. | Turbines, 625 revs. | H.P. turbine, 2,600 revs.; L.P. turbine, 1,800 revs. |
| Referred mean pressure | 30·75 | 43·0 | — | — | — |
| Condenser surface per H.P. | 1·42 | 1·4 | 1·35 | 0·75 | 0·6 |
| Boilers— | | | | | |
| No. and type | Five S.E. cylindrical | Four S.E. cylindrical | Two D.E. and one S.E. cylindrical | Seven water-tube | Eight water-tube |
| Working pressure (lb. per sq. in.) | 160 | 180 | 150 | 190 | 195 |
| System of draught | Natural | Forced | Forced | Forced | Forced |
| Heating surface per H.P. (sq. ft.) | 2·6 | 1·95 | 1·9 | 1·95 | 2 |
| H.P. per sq. ft. of grate | 12·25 | 17·5 | 16·5 | 15·0 | 22·0 |
| Total weight of machinery— Steam up | 590 tons | 610 tons | 590 tons | 735 tons | 1,055 tons |
| H.P. per ton of machinery | 7·45 | 9·62 | 9·3 | 11·6 | 11·65 |
| Coal consumption per H.P. hour | 2·25 lb. | 2·1 lb. | 1·8 lb. | 1·7 lb. | 1·50 lb. |

PROGRESS IN MARINE MACHINERY—MOTOR SHIPS.

| | 1909. | 1910. | 1912. | 1914. | 1916. | 1920. |
|---|---|---|---|---|---|---|
| Ship Dimensions— | | | | | | |
| Length | 210 ft. | 260 ft. | 380 ft. | 425 ft. | 450 ft. | 502 ft. |
| Beam | 38 ft. | 43 ft. | 53 ft. | 55 ft. | 57 ft. | 62 ft. |
| Performance— | | | | | | |
| Speed | $8\frac{1}{2}$ knots | $10\frac{1}{2}$ knots | 11 knots | $11\frac{1}{4}$ knots | 12 knots | $13\frac{1}{4}$ knots |
| Indicated horse-power | 490 | 1,460 | 2,500 | 3,100 | 4,000 | 6,400 |
| Engines— | | | | | | |
| No. of propellers | 1 | 1 | 2 | 2 | 2 | 2 |
| Type of engine | 4-cycle single acting | 4-cycle single acting | 4-cycle single acting | 4-cycle single acting | 4-cycle single acting | 4-cycle single acting |
| Cylinders per shaft | 6 | 6 | 8 | 6 | 6 | 8 |
| Bore | $15\frac{3}{4}$ in. | 22 in. | $20\frac{7}{8}$ in. | $24\frac{7}{8}$ in. | $29\frac{1}{8}$ in. | $29\frac{1}{8}$ in. |
| Stroke | $23\frac{5}{8}$ in. | $39\frac{3}{8}$ in. | $28\frac{3}{4}$ in. | $37\frac{7}{8}$ in. | $43\frac{5}{16}$ in. | $45\frac{1}{4}$ in. |
| Revolutions per minute | 140 | 125 | 140 | 125 | 100 | 115 |
| Piston speed in feet per minute | 550 | 820 | 670 | 785 | 725 | 865 |
| Mean pressure, lbs. per square inch— | | | | | | |
| I.H.P. basis | 99 | 111 | 89·8 | 89·5 | 91 | 91·5 |
| B.H.P. basis | 75 | 83 | 68 | 67 | 68 | 69 |
| Type of Auxiliaries | Steam | Steam | Electric | Electric | Electric | Electric |
| Total weight of machinery | 91 tons | 220 tons | 390 tons | 475 tons | 600 tons | 940 tons |
| B.H.P. per ton of machinery | 4·3 | 5 | 4·8 | 4·9 | 5 | 5·1 |
| Oil consumption for all purposes per B.H.P.-hour | 0·6 lb. | 0·5 lb. | 0·47 lb. | 0·45 lb. | 0·45 lb. | 0·45 lb. |

MARINE DIESEL ENGINE, FOUR-CYCLE TYPE, DIAGRAM OF OPERATIONS.



## COMPARISONS OF STEAM AND OIL-ENGINED VESSELS.

The table given herewith of comparisons of the cost of operating steam and oil-engined vessels is of the same form as was given in last year's issue of "Brassey's Annual," page 183, but with the figures amended to come more into line with present-day prices. With the large reductions that have taken place in the prices of fuels, the much lesser cost of operating all types of ships will be noted.

The savings consequent upon the installation of Diesel machinery still, however, compel attention. The relative positions occupied by vessels propelled by the various types of prime movers remain substantially the same.

It is impossible in any such comparisons to take fully into account all the factors which may operate in the case of vessels trading on different routes, but it is hoped that the figures given herewith will indicate the nature and the order of the relative costs,

The following savings, which are effected by the installation of Diesel machinery, have not been taken into account: less fuelling costs, demurrage, no stand-by losses, less cleaning ship, higher average speed in a seaway, reduced fuelling appliances required, etc.

| Type of propelling machinery. | Diesel Engines. | Reciprocating Steam-Engines. | | Turbines. |
|---|---|---|---|---|
| | 4-cycle single-acting reversible, crosshead. Diesel electric-driven auxiliaries. | Triple expansion engines, cylindrical boilers, Howden's forced draught, Superheat 50° Fahr. | | With reduction gearing, oil fired, Superheat, 150° Fahr. |
| | | *Coal-Fired Boilers.* | *Oil-Fired Boilers.* | |
| Total deadweight in tons | 10,050 | 10,230 | 10,235 | 10,235 |
| Freight-earning cargo in tons . . . . . . . | 9,357 | 7,880 | 8,555 | 8,743 |
| Average sea-power. horse-power . . . | 2,500 (Shaft) | 2,800 (Indicated) | 2,800 (Indicated) | 2,500 (Shaft) |
| Radius of action in miles | 10,500 | 10,500 | 10,500 | 10,500 |
| Fuel consumption per brake horse-power hour, including auxiliaries, in lb. . . . . . | 0·45 | 2·0 | 1·4 | 1·1 |
| * Fuel consumption per day in tons . . . | 12·1 | 53·5 | 37·5 | 29·5 |
| Fuel consumption per voyage of 16 days, in tons . . . . . . | 194 | 856 | 600 | 472 |
| **Comparative Costs of Working.** | | | | |
| Provisions, total per month . . . . . | £201 5*s*. 0*d*. | £246 10*s*. 0*d*. | £208 10*s*. 0*d*. | £208 10*s*. 0*d*. |
| Wages, total per month . | £505 | £586 | £510 | £510 |
| Fuel, per 16 days' sailing | £873 (£4 10*s*. 0*d*. per ton) | £1,498 (£1 15*s*. 0*d*. per ton) | £2,250 (£3 15*s*. 0*d*. per ton) | £1,770 (£3 15*s*. 0*d*. per ton) |
| Fuel, per month of 24 days' sailing . . . | £1,310 | £2,247 | £3,375 | £2,650 |
| Cost of running for one year of 288 days' sailing | £24,195 | £36,954 | £49,122 | £40,422 |
| Tons of freight-earning cargo carried, assuming 9 round voyages per year, each of 32 days' total sailing out and home . . . . . . | 168,426 | 141,840 | 153,990 | 157,274 |
| Cost per ton of cargo carried per 16 days' sailing out and home . | 2*s*. 10*d*. | 5*s*. 2*d*. | 6*s*. 5*d*. | 5*s*. 1*d*. |
| Cost per ton-mile . . | ·0085*d*. | ·0151*d*. | ·0189*d*. | ·0152*d*. |

* Calorific value of oil fuel taken at 19,000 B.Th.U.'s. Calorific value of coal taken at 13,500 B.Th.U.'s.

# LIST OF THE PRINCIPAL COMMERCIAL FUEL-OIL BUNKERING STATIONS ESTABLISHED THROUGHOUT THE WORLD.

VARIOUS publications, British and American, interested in oil or shipping matters furnish particulars from time to time of fuel oil bunkering stations, either by way of more or less comprehensive general lists or of announcements by oil distributing companies. Some of the more comprehensive lists, whilst valuable as showing the widespread provision of fuel oil supplies already made or contemplated, do not in all cases, however, distinguish between installations in actual operation and those under construction, or clearly indicate whether Government installations are the only ones existing at particular ports. In compiling the following list from many sources, our aim has been to specify the principal bunkering ports at which commercial oil installations are in operation, showing separately ports at which installations have been announced as proposed or under construction. Whilst absolute accuracy cannot be guaranteed, much care has been taken to eliminate errors.

Aalborg (Denmark)
Abadan (Persia)
Adelaide
Aden
Alexandria
Amoy
Amsterdam
Antofagasta (Chili)
Antwerp
Avonmouth
Azores
Bahia Blanca (Argentine)
Balik Pappan (Borneo)
Baltimore
Bangkok (Siam)
Barrow
Batum (Russia)
Batavia
Baton Rouge (Louisiana)
Bayonne, N.J.
Beaumont (Texas)
Belfast
Bergen
Bermuda
Bilbao
Birkenhead
Bizerta (Tunis)
Bombay
Bordeaux
Boston (U.S.A.)
Brixham
Buenos Aires
Calcutta
Callao
Canton
Cape Town
Christiania
Cienfuegos (Cuba)
Cochin (India)
Colombo
Colon (Panama Canal)
Constantinople
Constanza (Roumania)
Copenhagen
Curacao
Dublin
Dunkirk
Durban
Foochow
Fremantle
Galveston
Genoa
Glasgow
Gothenburg
Grangemouth
Guayaquil (Ecuador)
Halifax (Canada)
Hamburg
Hankow
Havana
Havre
Helsingfors (Finland)
Hong Kong
Honolulu
Hull
Iquique (Chili)
Karachi
Kingston (Jamaica)
Kobé
La Guayra (Venezuela)
Las Palmas
Lisbon
Liverpool
London :
  Thameshaven,
  Purfleet, etc.
Los Angeles
Macassar (Celebes)
Madeira
Madras
Malmo
Malta
Manchester Ship Canal
Manila
Maracaibo (Venezuela)
Marseilles
Melbourne
Minatitlan (Mexico)
Mombasa
Montevideo
Montreal
Nagasaki
Naples
Newcastle-on-Tyne
New Orleans
Nordenham
Norfolk (Va.)
New York
Odense (Denmark)

Palembang (Sumatra)
Palermo
Panama Canal
Para (Brazil)
Penang
Pensacola (Florida)
Perim
Pernambuco
Philadelphia
Piræus
Plymouth
Portishead
Portland (Ore)
Port Arthur (Texas)
Port Said
Port Sudan
Prince Rupert (British Columbia)
Puerto-Mexico
Quebec
Rangoon
Rio de Janeiro
Rotterdam
Rouen
Saigon (French Cochin China)
St. Nazaire
St. Thomas (West Indies)
St. Vincent (Cape Verde)
Salina Cruz (Mexico)
San Francisco
San Juan (Porto Rica)
San Pedro (California)
Santos (Brazil)
Savannah (Georgia)
Seattle (Wash.)
Shanghai
Singapore :
  Pulo Samboe
  Pulo Bukum
Sourabaya (Java)
Southampton
South Shields
Spezia
Stavanger (Norway)
Stockholm
Suez
Sunderland
Svolvaer (Norway)
Swansea
Swatow
Sydney
Talara (Peru)
Taltal (Chili)
Tampico (Mexico)
Tarakan (Borneo)
Tientsin
Tocopilla (Chili)
Trieste
Trinidad
Tunis
Tuticorin (India)
Tuxpam (Mexico)
Vallo (Norway)
Valparaiso
Vancouver
Vera Cruz (Mexico)
Yokohama
Zanzibar

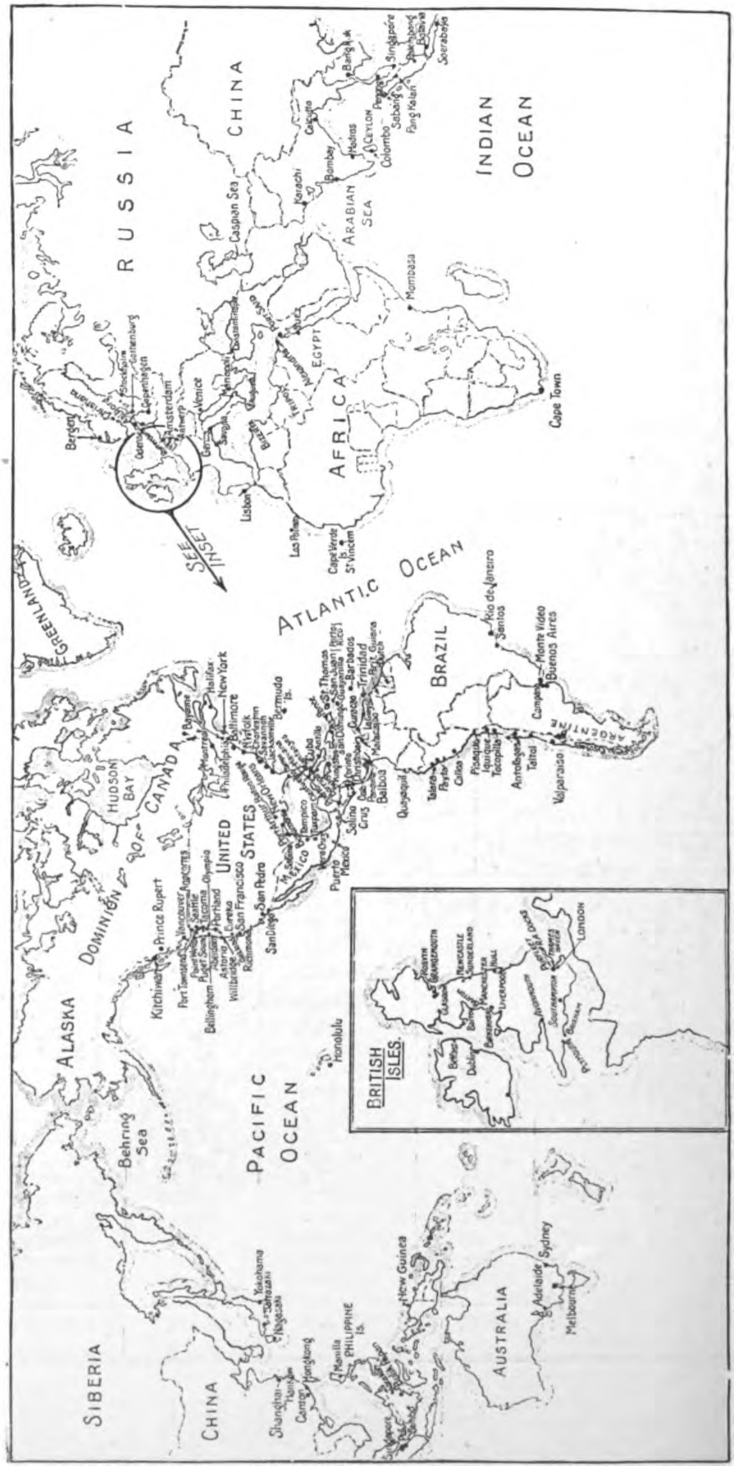
The following are some of the ports at which oil installations are reported to be under construction or contemplated:—

Cardiff
Gibraltar
Granton
La Pallice
St. John (New Brunswick)
Salonika
Smyrna
Vado (Italy)
Victoria (B.C.)
Wellington (N.Z.)

NUMBER AND TONNAGE OF MOTOR VESSELS (INCLUDING VESSELS FITTED WITH AUXILIARY MOTORS) OWNED BY VARIOUS NATIONS.

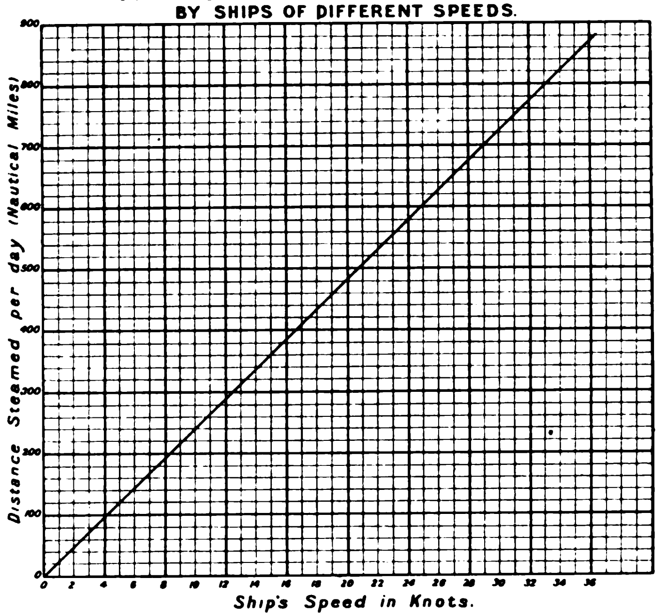
| | June, 1920. | | June, 1921. | |
|---|---|---|---|---|
| | Number. | Gross tonnage. | Number. | Gross tonnage. |
| United Kingdom | 130 | 136,807 | 180 | 263,128 |
| British Dominions | 96 | 53,413 | 104 | 50,104 |
| United States | 159 | 183,448 | 173 | 188,125 |
| Denmark | 93 | 116,874 | 96 | 150,202 |
| Holland | 104 | 52,963 | 89 | 50,262 |
| France | 48 | 37,675 | 68 | 43,235 |
| Germany | 33 | 5,252 | 69 | 16,688 |
| Italy | 46 | 49,233 | 65 | 64,791 |
| Japan | 5 | 3,779 | 7 | 6,654 |
| Norway | 211 | 146,771 | 233 | 157,313 |
| Russia | 16 | 3,515 | 15 | 8,511 |
| Spain | 20 | 5,919 | 34 | 14,522 |
| Sweden | 124 | 98,623 | 167 | 137,329 |
| Other countries | 88 | 43,888 | 152 | 96,357 |
| World's total | 1,173 | 938,160 | 1,452 | 1,247,221 |

MAP OF THE WORLD, SHOWING PORTS WHERE OIL STORAGE IS PROVIDED.

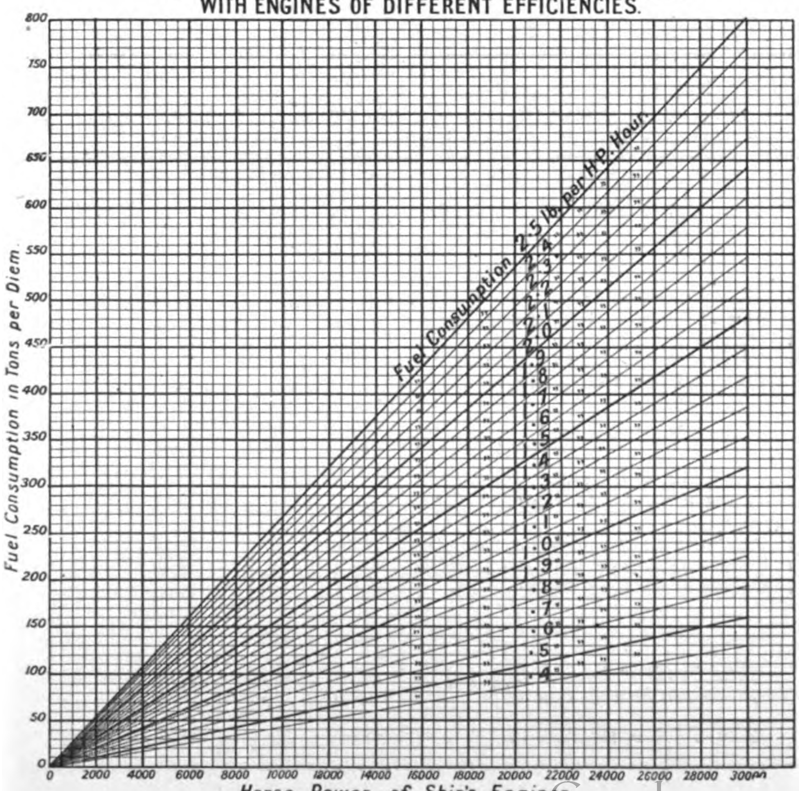



(*Reprinted from "The Motor Ship."*)

DIAGRAM SHOWING DISTANCE STEAMED IN ONE DAY BY SHIPS OF DIFFERENT SPEEDS.




DAILY FUEL CONSUMPTION OF STEAMERS & MOTOR SHIPS WITH ENGINES OF DIFFERENT EFFICIENCIES.



## SEABORNE TRADE OF THE WORLD.

STATEMENT SHOWING THE IMPORTS (EXCLUDING BULLION AND SPECIE) INTO ALL THE COUNTRIES OF THE WORLD FOR THE YEAR 1912 FROM ALL OTHER COUNTRIES, WITH THE ESTIMATED PROPORTION CARRIED BY BRITISH VESSELS. (*See diagram, p.* 449.)

| Countries into which Imported. | Estimated Total Imports by Sea. | Estimated Amount carried by British Vessels. | Estimated Proportion carried by British Vessels. |
|---|---|---|---|
| 1. *Inter-Imperial Trade :—* | Million £. | Million £. | Per Cent. |
| Into United Kingdom from Empire . . | 212 | 199 | 94 |
| Into Empire from United Kingdom . . | 206 | 144 | |
| Into British Possessions outside the United Kingdom from British Possessions outside the United Kingdom . . | 92 | 78 | 85 |
| Total (1) . . | 510 | 471 | 92 |
| 2. *Foreign Trade of the Empire :—* | | | |
| Into United Kingdom from Foreign Countries . . . . . . . . . . | 533 | 346 | 65 |
| Into Foreign Countries from United Kingdom . . . . . . . . . | 420 | 281 | 67 |
| Into Empire from Foreign Countries . | 143 | 79 | 55 |
| Into Foreign Countries from Empire . | 230 | 126 | |
| Total (2) . . | 1326 | 832 | 63 |
| *Total Trade of Empire* (1 *and* 2) . | 1836 | 1303 | 71 |
| 3. *Into Foreign Countries from Foreign Countries* . . . . . . . . . | 1550 | 465 | 30 |
| *Total Trade of the World* . . . | 3386 | 1768 | 52 |

STATEMENT SHOWING THE ENTRANCES WITH CARGOES AND IN BALLAST IN THE INTERNATIONAL OVERSEAS TRADE OF THE WORLD FOR THE YEAR 1911/1912 WITH THE PROPORTION OF ENTRANCES OF BRITISH VESSELS. (*See diagram, p.* 419.)

| Vessels Entered. | With Cargoes and in Ballast. | | | British Proportion. |
|---|---|---|---|---|
| | British Vessels. | Foreign Vessels. | Total. | |
| 1. *Inter-Imperial Trade :—* | Million tons net. | Million tons net. | Million tons net. | Per Cent. |
| At United Kingdom Ports from Empire | 8·9 | 1·0 | 9·9 | 90 |
| At Empire Ports from United Kingdom | 10·0 | 1·0 | 11·0 | 91 |
| At Empire Ports outside United Kingdom from other Empire Ports outside United Kingdom . . . . . . . | 21·8 | 5·4 | 27·2 | 80 |
| Total (1) . . | 40·7 | 7·4 | 48·1 | 85 |
| 2. *Foreign Trade of the Empire :—* | | | | |
| At United Kingdom Ports from Foreign Countries . . . . . . . . . | 35·4 | 30·9 | 66 3 | 53 |
| At Foreign Ports from United Kingdom | 34·3 | 31·0 | 65·3 | 53 |
| At Empire Ports from Foreign Countries | 25·2 | 26·3 | 51·5 | 49 |
| At Foreign Ports from Empire Ports . | 28·4 | 26·6 | 55·0 | 51 |
| Total (2) . . | 123 3 | 114·8 | 238·1 | 52 |
| *Total Trade of Empire* (1 *and* 2) . | 164·0 | 122·2 | 286·2 | 57 |
| 3. *Trade between Foreign Countries* . . | 67·0 | 214·0 | 281·0 | 24 |
| *Total Trade of the World* . . . . | 231 0 | 336·2 | 567·2 | 41 |

Diagram showing the Employment of Shipping of all Nations in 1911 in the International Trade of the World. Tonnage Entrances and Clearances with Cargoes and in Ballast in the Foreign Trade are Plotted for all Countries in which the Amount exceeded 10,000,000 tons.

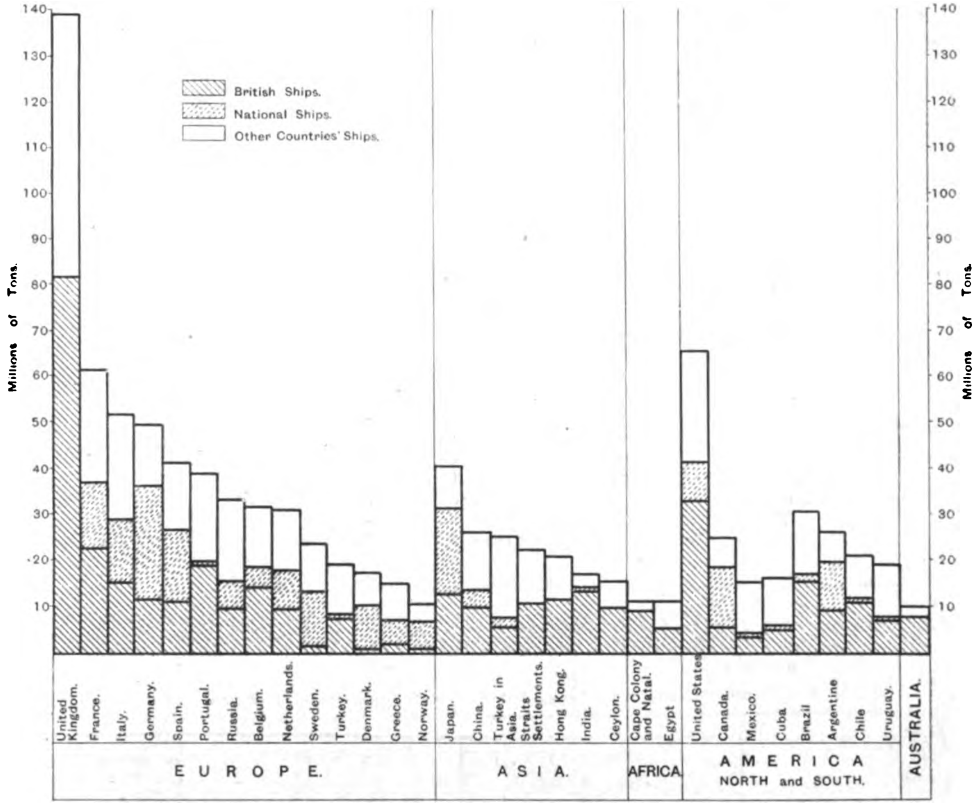
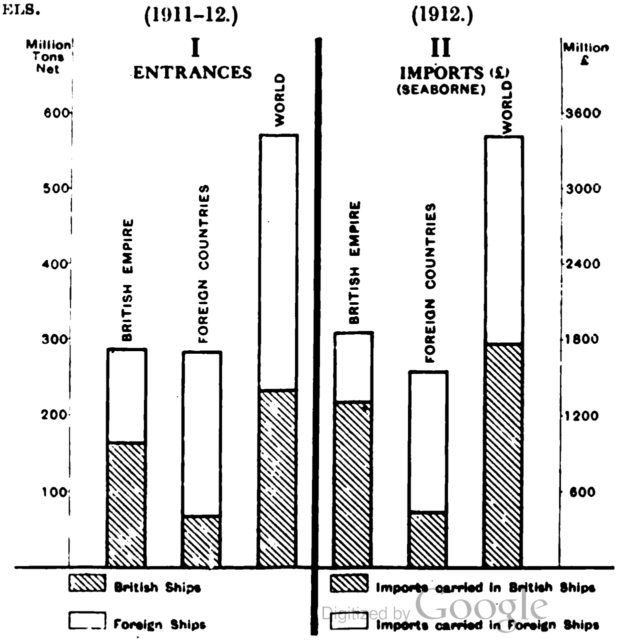



Diagram showing (I) the Proportion of the Total Entrances with Cargoes and in Ballast of British Vessels in the International Overseas Trade of the World; and (II) the estimated Proportion of the Imports into all Countries of the World carried in British Vessels.



## STATEMENT SHOWING THE VALUE OF THE IMPORTS FOR HOME CONSUMPTION AND EXPORTS OF DOMESTIC PRODUCE OF THE PRINCIPAL COUNTRIES FOR THE YEARS 1913, 1919, AND 1920.

(Foreign currencies converted to sterling at par.)

| Countries. | Imports. 1913. | Imports. 1919. | Imports. 1920. | Exports. 1913. | Exports. 1919. | Exports. 1920. |
|---|---|---|---|---|---|---|
| | Thousand £. | Thousand £. | Thousand £. | Thousand £. | Thousand £. | Thousand £. |
| United Kingdom . . | 652,692 | 1,461,408 | 1,714,332 | 524,532 | 798,636 | 1,335,564 |
| United States . . . | 366,012 | 777,864 | 1,068,948 | 510,060 | 1,614,540 | 1,683,432 |
| France . . . . . | 336,852 | 1,431,972 | 1,416,204 | 275,208 | 475,188 | 897,396 |
| Netherlands . . . . | 325,236 | 235,476 | 277,704 | 255,456 | 117,612 | 141,792 |
| Belgium . . . . . | 165,460 | 208,536 | 446,616 | 145,380 | 91,248 | 347,532 |
| Italy . . . . . . | 145,824 | 664,932 | 634,488 | 100,464 | 242,628 | 312,156 |
| Canada . . . . . | 135,648 | 193,428 | 274,812 | 89,664 | 255,096 | 216,600 |
| British India . . . | 122,220 | 122,928 | 209,628 | 160,836 | 191,932 | 188,616 |
| Switzerland . . . . | 74,376 | 140,352 | 168,048 | 54,864 | 131,916 | 130,980 |
| Japan . . . . . . | 74,076 | 216,960 | 234,192 | 64,260 | 210,900 | 195,588 |
| Brazil . . . . . . | 67,164 | 78,180 | 124,404 | 65,448 | 130,080 | 107,520 |
| Spain . . . . . . | 52,248 | 35,940 | Not available | 42,300 | 52,656 | Not available |
| Denmark . . . . . | 43,188 | 132,960 | 163,800 | 35,412 | 41,160 | 87,492 |
| Union of South Africa . | 40,380 | 46,824 | 96,096 | 27,528 | 48,132 | 42,252 |
| New Zealand . . . | 21,420 | 29,700 | 60,744 | 21,048 | 51,876 | 44,628 |

## STATEMENT SHOWING THE ESTIMATED WEIGHT OF IMPORTS INTO AND EXPORTS FROM THE UNDERMENTIONED COUNTRIES FOR THE YEARS 1913 AND 1919.

Note.—G = General Imports or Exports. S = Special Imports or Exports.

| Country. | Imports. Description of trade. | Imports. Percentage of trade by value represented. | Imports. 1913. | Imports. 1919. | Exports. Description of trade. | Exports. Percentage of trade by value represented. | Exports. 1913. | Exports. 1919. | 1919 as percentage of 1913. Imports. | 1919 as percentage of 1913. Exports. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Thousands of metric tons. | Thousands of metric tons. | | | Thousands of metric tons. | Thousands of metric tons. | | |
| United Kingdom | G | 100 | 55,440 | 39,600 | G | 100 | 94,444 | 48,416 | 71 | 51 |
| Netherlands | G* | 100 | 44,864 | 10,848 | G* | 100 | 29,412 | 2,727 | 24 | 9 |
| France | S | 100 | 44,220 | 31,658 | S | 100 | 22,076 | 3,020 | 72 | 14 |
| Belgium | S | 100 | 32,660 | 4,537 | S | 100 | 20,884 | 6,875 | 14 | 33 |
| Canada | S | 39 | 22,456 | 20,402 | G | 62 | 8,980 | 10,211 | 91 | 114 |
| United States | G | 80 | 20,060 | 24,304 | S | 70 | 48,048 | 56,168 | 121 | 117 |
| Italy | S | 100 | 19,316 | 12,839 | S | 100 | 4,504 | 1,750 | 66 | 39 |
| Argentine | S | 84 | 9,360 | 3,031 | S | 96 | 11,696 | 8,590 | 32 | 73 |
| Denmark | G | 92 | 8,220 | 4,285 | G | 84 | 1,916 | 368 | 52 | 19 |
| Sweden | G | 93 | 7,936 | 3,781 | S | 74 | 10,812 | 4,020 | 48 | 37 |
| Switzerland | S | 95 | 7,752 | 4,000 | S | 90 | 856 | 948 | 52 | 111 |
| Spain | S | 100 | 5,916 | 2,427 | S | 88 | 14,460 | 7,721 | 41 | 53 |
| Brazil | G | 100 | 5,872 | 2,780 | S | 100 | 1,384 | 1,908 | 47 | 138 |
| Japan | G | 89 | 5,272 | 7,763 | S | 63 | 4,572 | 2,934 | 147 | 64 |
| Norway | G | 70 | 4,952 | 3,208 | S | 75 | 4,012 | 1,313 | 65 | 33 |
| British India | G | 36 | 4,544 | 2,237 | G | 85 | 10,700 | 5,601 | 49 | 52 |
| Totals | — | — | 298,840 | 177,700 | — | — | 288,756 | 162,570 | 59 | 56 |

* Total imports or exports less direct transit.

STATEMENT SHOWING THE ENTRANCES AND CLEARANCES IN THE FOREIGN TRADE OF THE UNDERMENTIONED COUNTRIES FOR THE YEARS 1913, 1919, AND 1920.

Note.—C = With Cargo only. C & B = With Cargo and in Ballast.

| Countries. | | Entrances. | | | Clearances. | | |
|---|---|---|---|---|---|---|---|
| | | 1913. | 1919. | 1920. | 1913. | 1919. | 1920. |
| | | Thousand tons net. | Thousand tons net. | Thousand tons net. | Thousand tons net. | Thousand tons net. | Thousand tons net. |
| United Kingdom | C | 49,068 | 29,568 | 36,516 | 67,824 | 34,560 | 36,588 |
| United States | C & B | 53,280 | 46,704 | 64,128 | 53,796 | 51,252 | 67,824 |
| France | C | 34,512 | 22,836 | 28,788 | 26,112 | 9,384 | 16,944 |
| Japan | C & B | 24,720 | 22,824 | 26,136 | 24,900 | 23,124 | 26,592 |
| Netherlands | C | 17,148 | 5,760 | 8,700 | 11,016 | 3,432 | 6,324 |
| Spain | C | 7,404 | 2,952 | Not available. | 12,024 | 5,664 | Not available. |
| British India | C | 6,780 | 5,172 | 6,552 | 8,256 | 6,168 | 7,044 |
| Australia | C & B | 5,364 | 3,240 | 4,236 | 5,232 | 2,940 | 4,152 |
| South Africa | C & B | 5,352 | 3,648 | 4,080 | 5,280 | 3,588 | 4,128 |
| Norway | C | 3,756 | 2,532 | Not available. | 4,740 | 2,232 | Not available. |

ABOVE AS PERCENTAGES OF 1913 FIGURES.

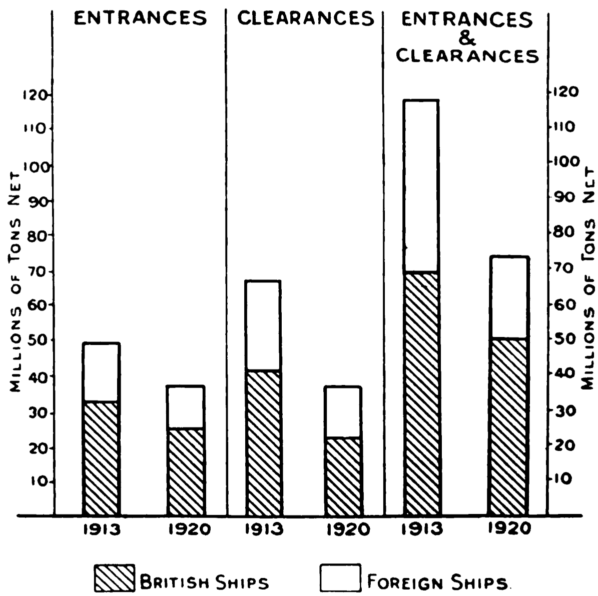
| | | | | | | |
|---|---|---|---|---|---|---|
| United Kingdom | 100 | 60 | 74 | 100 | 51 | 54 |
| United States | 100 | 87 | 120 | 100 | 95 | 126 |
| France | 100 | 66 | 84 | 100 | 36 | 65 |
| Japan | 100 | 92 | 106 | 100 | 93 | 107 |
| Netherlands | 100 | 34 | 51 | 100 | 31 | 57 |
| Spain | 100 | 40 | — | 100 | 47 | — |
| British India | 100 | 76 | 97 | 100 | 75 | 85 |
| Australia | 100 | 60 | 79 | 100 | 56 | 79 |
| South Africa | 100 | 68 | 76 | 100 | 68 | 78 |
| Norway | 100 | 67 | — | 100 | 47 | — |

STATEMENT SHOWING THE NATIONALITY AND NET TONNAGE OF VESSELS WHICH ENTERED AND CLEARED WITH CARGOES IN THE FOREIGN TRADE OF THE UNITED KINGDOM FOR THE YEARS 1913 AND 1920. (*See diagram below.*)

| Nationality | Entrances. | | Clearances. | | Percentages. Entrances. | | Percentages. Clearances. | |
|---|---|---|---|---|---|---|---|---|
| | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. |
| | Tons.* | Tons.* | Tons.* | Tons.* | | | | |
| British | 32,291 | 25,531 | 40,102 | 23,408 | 65·8 | 69·9 | 59·1 | 64·0 |
| *Foreign:—* | | | | | | | | |
| Norwegian | 3,285 | 1,832 | 4,683 | 2,919 | 6·7 | 5·0 | 6·9 | 8·0 |
| United States of America | 724 | 2,357 | 370 | 1,242 | 1·5 | 6·5 | 0·5 | 3·4 |
| Swedish | 1,891 | 1,288 | 3,016 | 1,118 | 3·9 | 3·5 | 4·5 | 3·0 |
| Dutch | 1,702 | 1,283 | 2,536 | 1,434 | 3·5 | 3·5 | 3·7 | 3·9 |
| Danish | 1,161 | 732 | 2,613 | 1,255 | 2·4 | 2·0 | 3·9 | 3·4 |
| French | 999 | 938 | 1,975 | 2,027 | 2·0 | 2·6 | 2·9 | 5·5 |
| Belgian | 1,369 | 709 | 957 | 827 | 2·8 | 1·9 | 1·4 | 2·3 |
| Japanese | 140 | 441 | 282 | 417 | 0·3 | 1·2 | 0·4 | 1·1 |
| Spanish | 1,060 | 402 | 1,694 | 439 | 2·2 | 1·1 | 2·5 | 1·2 |
| Italian | 122 | 174 | 955 | 488 | 0·2 | 0·5 | 1·4 | 1·3 |
| Russian | 678 | 122 | 937 | 95 | 1·4 | 0·3 | 1·4 | 0·3 |
| Greek | 221 | 174 | 1,072 | 310 | 0·4 | 0·5 | 1·6 | 0·9 |
| German | 3,166 | 199 | 5,730 | 252 | 6·4 | 0·6 | 8·5 | 0·7 |
| Austro-Hungarian | 128 | — | 715 | — | 0·3 | — | 1·0 | — |
| Other Nationalities | 125 | 336 | 185 | 358 | 0·2 | 0·9 | 0·3 | 1·0 |
| Total Foreign | 16,772 | 10,987 | 27,719 | 13,181 | 34·2 | 30·1 | 40·9 | 36·0 |
| Total British and Foreign | 49,063 | 36,518 | 67,821 | 36,589 | 100·0 | 100·0 | 100·0 | 100·0 |

| | Entrances and Clearances. 1913. | Entrances and Clearances. 1920. | Percentages. 1913. | Percentages. 1920. |
|---|---|---|---|---|
| | Tons.* | Tons.* | | |
| British | 72,393 | 48,939 | 62 | 67 |
| Foreign | 44,490 | 24,168 | 38 | 33 |
| Total | 116,883 | 73,107 | 100 | 100 |

* *Figures in thousands,* i.e. *hundreds omitted.*

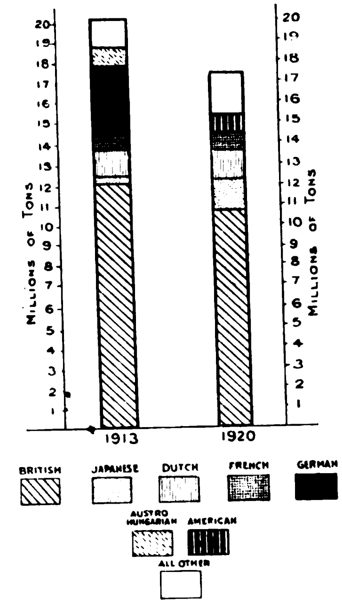


STATEMENT SHOWING THE NUMBER AND NET TONNAGE OF VESSELS THAT PASSED THROUGH THE SUEZ CANAL IN THE YEARS 1913 AND 1920, DISTINGUISHING THE PRINCIPAL NATIONALITIES.

| Nationality of Vessels. | Number of Passages. | | Net Tonnage of Vessels. | | Numbers as Percentages of Total. | | Tonnages as Percentages of Total. | |
|---|---|---|---|---|---|---|---|---|
| | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. |
| British | 2951 | 2359 | 12,052,484 | 10,838,842 | 58·0 | 58·8 | 60·2 | 61·7 |
| Japanese | 68 | 385 | 343,722 | 1,601,468 | 1·3 | 9·6 | 1·7 | 9·1 |
| Dutch | 342 | 330 | 1,287,354 | 1,425,808 | 6·7 | 8·2 | 6·4 | 8·1 |
| French | 256 | 184 | 927,787 | 774,784 | 5·0 | 4·6 | 4·6 | 4·4 |
| Inter-Allied | — | 107 | — | 525,816 | — | 2·7 | — | 3·0 |
| Italian | 110 | 188 | 290,576 | 605,564 | 2·2 | 4·7 | 1·5 | 3·4 |
| Danish | 56 | 53 | 171,848 | 230,031 | 1·1 | 1·3 | 0·9 | 1·3 |
| Norwegian | 44 | 49 | 93,313 | 172,127 | 0·9 | 1·2 | 0·5 | 1·0 |
| American (U.S.) | 8 | 152 | 7,476 | 723,716 | 0·2 | 3·8 | — | 4·1 |
| Swedish | 33 | 58 | 122,957 | 230,175 | 0·7 | 1·4 | 0·6 | 1·3 |
| Greek | 17 | 44 | 54,560 | 119,975 | 0·3 | 1·1 | 0·3 | 0·7 |
| Spanish | 26 | 28 | 75,643 | 71,835 | 0·5 | 0·7 | 0·4 | 0·4 |
| German | 778 | 3 | 3,352,287 | 14,777 | 15·3 | 0·1 | 16·7 | 0·1 |
| Austria-Hungarian | 246 | — | 845,830 | — | 4·8 | — | 4·2 | — |
| Russian | 110 | 18 | 340,595 | 46,328 | 2·2 | 0·5 | 1·7 | 0·3 |
| All others | 40 | 51 | 67,422 | 193,411 | 0·8 | 1·3 | 0·3 | 0·1 |
| Total | 5085 | 4009 | 20,033,802 | 17,574,657 | 100·0 | 100·0 | 100·0 | 100·0 |

NOTE.—The above figures include not only Merchant Vessels and Mail Steamers, but also Warships and Transports as well as Government Chartered Vessels.

NET TONNAGE AND NATIONALITIES OF VESSELS PASSED THROUGH SUEZ CANAL, 1913 AND 1920.



STATEMENT SHOWING THE NUMBER AND NET TONNAGE OF COMMERCIAL VESSELS THAT PASSED THROUGH THE PANAMA CANAL IN THE YEARS ENDED 30TH JUNE, 1915, 1916, 1917, 1918, 1919, 1920, AND 1921, DISTINGUISHING THE PRINCIPAL NATIONALITIES. (*See diagram* A, *page* 456.

(NOTE.—Commercial Vessels include all Vessels except those of the United States Government, or chartered by the U.S. Government to carry Government supplies, and Vessels of less than 10 tons measurement).

| Nationality. | Number of Vessels. 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| British | 465 | 358 | 780 | 702 | 607 | 753 | 972 |
| American (U.S.A.)* | 459 | 213 | 404 | 567 | 784 | 1,129 | 1,210 |
| Norwegian | 42 | 44 | 145 | 296 | 128 | 106 | 140 |
| Japanese | 6 | 24 | 72 | 54 | 87 | 118 | 136 |
| Chilian | 35 | 33 | 99 | 96 | 93 | 79 | 63 |
| Danish | 24 | 18 | 43 | 100 | 79 | 9 | 60 |
| Peruvian | 4 | 30 | 86 | 83 | 64 | 75 | 60 |
| Dutch | 7 | 15 | 74 | 48 | 19 | 29 | 50 |
| French | 3 | 1 | 9 | 52 | 104 | 60 | 44 |
| Spanish | — | — | 20 | 11 | 5 | 41 | 44 |
| Other Nationalities | 30 | 22 | 71 | 60 | 54 | 79 | 113 |
| Totals | 1,075 | 758 | 1,803 | 2,069 | 2,024 | 2,478 | 2,892 |

| Nationality. | Net Tonnage of Vessels. 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| British | 1,630,833 | 1,161,097 | 2,663,250 | 2,529,203 | 1,915,744 | 2,760,188 | 3,978,329 |
| American (U.S.A.)* | 1,700,145 | 652,989 | 1,239,492 | 1,704,040 | 2,257,342 | 3,791,088 | 4,861,761 |
| Norwegian | 130,776 | 172,459 | 490,534 | 876,024 | 497,555 | 397,632 | 548,227 |
| Japanese | 24,897 | 81,818 | 291,500 | 238,814 | 341,064 | 515,243 | 613,245 |
| Chilian | 94,638 | 91,243 | 265,210 | 254,841 | 253,561 | 212,000 | 159,727 |
| Danish | 92,537 | 68,011 | 163,882 | 272,946 | 213,534 | 32,221 | 236,512 |
| Peruvian | 9,403 | 74,429 | 218,593 | 208,958 | 166,956 | 191,689 | 157,495 |
| Dutch | 21,075 | 39,642 | 260,500 | 197,627 | 88,299 | 152,535 | 248,801 |
| French | 10,703 | 4,343 | 38,889 | 147,805 | 253,774 | 114,664 | 155,889 |
| Spanish | — | — | 49,124 | 24,469 | 11,066 | 106,651 | 117,400 |
| Other Nationalities | 77,565 | 50,131 | 117,583 | 119,346 | 126,095 | 272,133 | 338,490 |
| Totals | 3,792,572 | 2,396,162 | 5,798,557 | 6,574,073 | 6,124,990 | 8,546,044 | 11,415,876 |

ABOVE AS PERCENTAGES.

| Nationality. | 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| British | 43·2 | 47·2 | 43·3 | 33·9 | 30·0 | 30·4 | 33·6 |
| American (U.S.A.)* | 42·7 | 28·1 | 22·4 | 27·4 | 38·7 | 45·6 | 41·8 |
| Norwegian | 3·9 | 5·8 | 8·0 | 14·3 | 6·3 | 4·3 | 4·9 |
| Japanese | 0·6 | 3·2 | 4·0 | 2·6 | 4·3 | 4·8 | 4·7 |
| Chilian | 3·2 | 4·3 | 5·5 | 4·7 | 4·6 | 3·2 | 2·2 |
| Danish | 2·2 | 2·4 | 2·4 | 4·8 | 3·9 | 0·3 | 2·1 |
| Peruvian | 0·4 | 4·0 | 4·8 | 4·0 | 3·2 | 3·0 | 2·1 |
| Dutch | 0·7 | 2·0 | 4·1 | 2·3 | 0·9 | 1·2 | 1·7 |
| French | 0·3 | 0·1 | 0·5 | 2·5 | 5·1 | 2·4 | 1·5 |
| Spanish | — | — | 1·1 | 0·6 | 0·3 | 1·6 | 1·5 |
| Other Nationalities | 2·8 | 2·9 | 3·9 | 2·9 | 2·7 | 3·2 | 3·9 |
| Totals | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

| Nationality. | 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| British | 43·0 | 48·5 | 45·9 | 38·5 | 31·3 | 32·3 | 34·8 |
| American (U.S.A.)* | 44·8 | 27·2 | 21·4 | 25·9 | 36·8 | 44·4 | 42·6 |
| Norwegian | 3·5 | 7·2 | 8·5 | 13·3 | 8·1 | 4·7 | 4·8 |
| Japanese | 0·7 | 3·4 | 5·0 | 3·6 | 5·6 | 6·0 | 5·4 |
| Chilian | 2·5 | 3·8 | 4·6 | 3·9 | 4·1 | 2·5 | 1·4 |
| Danish | 2·4 | 2·8 | 2·8 | 4·2 | 3·5 | 0·4 | 2·1 |
| Peruvian | 0·2 | 3·1 | 3·8 | 3·2 | 2·7 | 2·2 | 1·4 |
| Dutch | 0·6 | 1·7 | 4·5 | 3·0 | 1·4 | 1·8 | 2·2 |
| French | 0·3 | 0·2 | 0·7 | 2·2 | 4·2 | 1·3 | 1·4 |
| Spanish | — | — | 0·8 | 0·4 | 0·2 | 1·2 | 1·0 |
| Other Nationalities | 2·0 | 2·1 | 2·0 | 1·8 | 2·1 | 3·2 | 2·9 |
| Totals | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

* Includes Vessels engaged in the coasting trade of the U.S.A. which is carried on *entirely* by National Ships.

STATEMENT SHOWING (IN TONS WEIGHT) THE CARGOES CARRIED IN COMMERCIAL VESSELS THAT PASSED THROUGH THE PANAMA CANAL DURING THE YEARS ENDED 30TH JUNE, 1915, 1916, 1917, 1918, 1919, 1920, AND 1921, DISTINGUISHING THE PRINCIPAL NATIONALITIES. (*See diagram* A, *page* 456.)

| Nationality of Vessels. | Weight of Cargoes carried. | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. |
| British . . . . | 2,200,514 | 1,570,660 | 3,393,750 | 2,615,675 | 1,876,939 | 2,830,268 | 3,738,257 |
| American (U.S.A.) | 2,187,904 | 848,857 | 1,475,725 | 2,098,277 | 2,758,886 | 4,547,140 | 5,163,025 |
| Norwegian . . . | 166,522 | 229,368 | 597,581 | 1,090,823 | 577,679 | 404,323 | 637,887 |
| Japanese . . . | 42,600 | 117,780 | 446,358 | 407,399 | 503,427 | 726,338 | 758,617 |
| Chilian . . . . | 50,879 | 53,573 | 184,446 | 153,259 | 161,340 | 104,738 | 61,737 |
| Danish . . . . | 116,603 | 94,950 | 242,567 | 420,063 | 325,277 | 42,533 | 322,059 |
| Peruvian . . . | 8,202 | 62,210 | 159,609 | 143,344 | 121,524 | 119,418 | 105,322 |
| Dutch . . . . | 26,402 | 61,959 | 314,203 | 233,063 | 119,297 | 128,442 | 216,488 |
| French . . . . | 13,600 | 7,176 | 36,680 | 159,859 | 286,812 | 125,249 | 132,836 |
| Spanish . . . | — | — | 71,080 | 35,394 | 10,047 | 101,563 | 143,076 |
| Other Nationalities | 75,228 | 47,581 | 136,564 | 174,875 | 175,393 | 244,487 | 319,910 |
| Totals . . . | 4,888,454 | 3,094,114 | 7,058,563 | 7,532,031 | 6,916,621 | 9,374,499 | 11,599,214 |

ABOVE AS PERCENTAGES.

| | 1915. | 1916. | 1917. | 1918. | 1919. | 1920. | 1921. |
|---|---|---|---|---|---|---|---|
| British . . . . | 45·0 | 50·8 | 48·1 | 34·7 | 27·1 | 30·2 | 32·2 |
| American (U.S.A.) | 44·8 | 27·4 | 20·9 | 27·9 | 39·9 | 48·5 | 44·5 |
| Norwegian . . . | 3·4 | 7·4 | 8·5 | 14·5 | 8·4 | 4·3 | 5·5 |
| Japanese . . . | 0·9 | 3·8 | 6·3 | 5·4 | 7·3 | 7·7 | 6·5 |
| Chilian . . . . | 1·0 | 1·7 | 2·6 | 2·0 | 2·3 | 1·1 | 0·5 |
| Danish . . . | 2·4 | 3·1 | 3·4 | 5·6 | 4·7 | 0·5 | 2·8 |
| Peruvian . . . | 0·2 | 2·0 | 2·3 | 1·9 | 1·8 | 1·3 | 0·9 |
| Dutch . . . . | 0·5 | 2·0 | 4·5 | 3·1 | 1·7 | 1·4 | 1·9 |
| French . . . | 0·3 | 0·2 | 0·5 | 2·1 | 4·2 | 1·3 | 1·2 |
| Spanish . . . . | — | — | 1·0 | 0·5 | 0·1 | 1·1 | 1·2 |
| Other Nationalities | 1·5 | 1·6 | 1·9 | 2·3 | 2·5 | 2·6 | 2·8 |
| Totals . . . | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

Diagram A.—Traffic Passed through Panama Canal, 1915–1921.

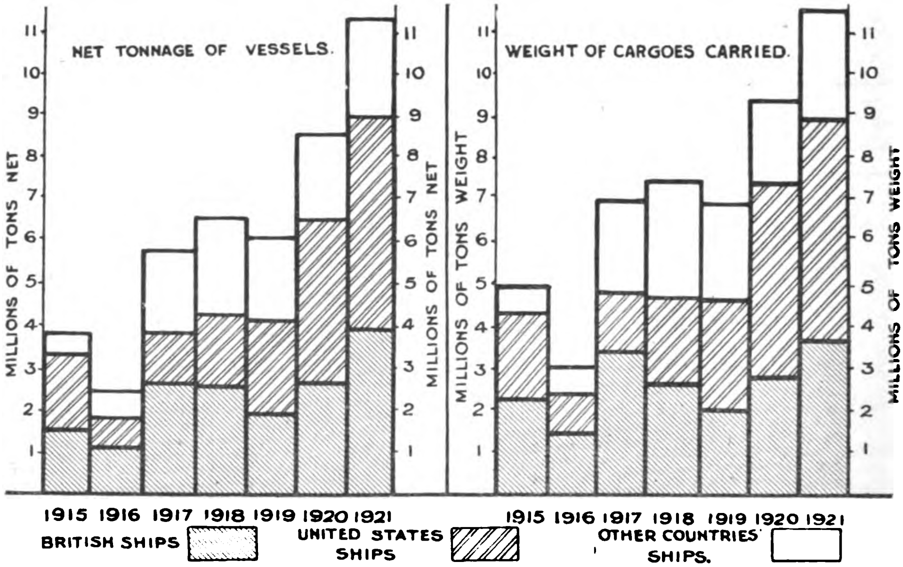
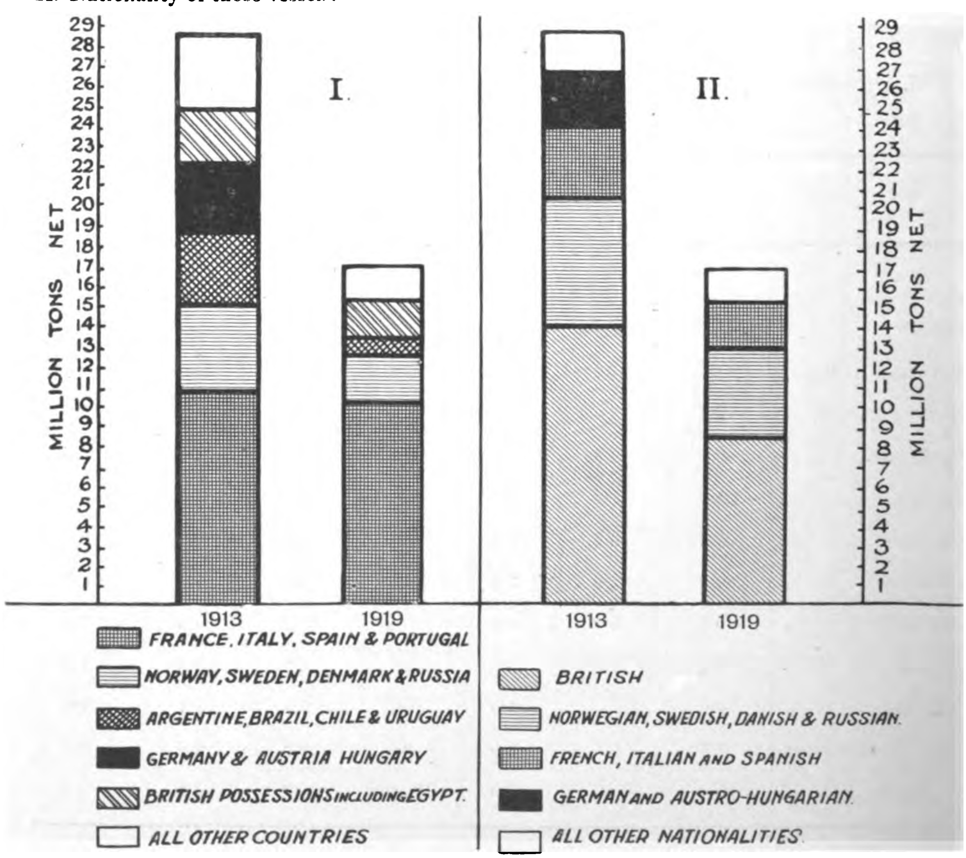



Diagram B.—Trade of British Coal Shipping Centres, 1913 and 1919.

I. Tonnage of vessels cleared with cargoes to British Possessions and Foreign Countries, showing countries to which vessels departed.

II. Nationality of those vessels.



## TRADE OF PRINCIPAL BRITISH COAL-SHIPPING CENTRES, 1913 & 1919.

| | Coal Exports. Tons. | | Other Exports. Tons. | |
|---|---|---|---|---|
| | 1913. | 1919. | 1913. | 1919. |
| Barry Docks and Penarth | 20,095,051 | 12,941,298 | 121,370 | 58,000 |
| Newcastle, North Shields, and South Shields | 13,619,502 | 7,855,065 | 318,445 | 221,000 |
| Blyth | 4,475,827 | 2,304,677 | 10,323 | 100 |
| Newport (Mon.) | 4,841,786 | 3,784,919 | 234,200 | 94,000 |
| Port Talbot, Briton Ferry, Neath Abbey, and Porthcawl | 2,318,699 | 1,771,307 | 5,374 | 3,000 |
| Sunderland | 4,027,806 | 1,705,440 | 3,592 | 3,000 |
| Swansea | 4,451,597 | 3,199,794 | 471,958 | 253,000 |
| Burntisland | 1,952,030 | 243,700 | 465 | 1,000 |
| Methil | 2,594,157 | 959,632 | 1,223 | 200 |
| Total Nine Centres | 58,376,455 | 34,765,832 | 1,166,960 | 633,300 |
| Total, United Kingdom | 76,687,000 | 38,466,000 | 16,937,000 | 9,106,000 |

STATEMENT SHOWING (IN RESPECT OF THE NINE PRINCIPAL COAL-SHIPPING CENTRES OF THE UNITED KINGDOM) FOR THE YEARS 1913 AND 1919 IN COLUMN I. THE NUMBER AND NET TONNAGE OF VESSELS WHICH CLEARED WITH CARGOES TO BRITISH POSSESSIONS AND TO EACH OF THE PRINCIPAL FOREIGN COUNTRIES, AND IN COLUMN II. THE TOTAL NUMBER AND TONNAGE OF EACH FOREIGN COUNTRY'S SHIPS WHICH CLEARED FROM THOSE CENTRES TO FOREIGN PORTS. (*See diagram* B, *page* 456.)

| Countries. | Column I. Countries to which Vessels departed. | | | | Column II.. Total Clearances of National Ships from the 9 Centres. | | | |
|---|---|---|---|---|---|---|---|---|
| | No. of Vessels. | | Net tonnage. | | No. of Vessels. | | Net tonnage. | |
| | 1913. | 1919. | 1913. | 1919. | 1913. | 1919. | 1913. | 1919. |
| Russia | 1,405 | 86 | 1,421,049 | 122,897 | 422 | 129 | 427,832 | 105,313 |
| Sweden | 1,582 | 1,194 | 1,187,765 | 686,871 | 1,993 | 1,915 | 1,582,746 | 1,166,195 |
| Norway | 1,517 | 1,290 | 866,001 | 835,367 | 4,280 | 4,028 | 3,007,900 | 2,509,914 |
| Denmark | 1,365 | 981 | 938,065 | 681,686 | 1,802 | 1,361 | 1,448,549 | 970,190 |
| Germany | 3,009 | 3 | 2,774,073 | 1,341 | 2,087 | — | 2,181,319 | — |
| Netherlands | 691 | 317 | 479,126 | 240,134 | 609 | 843 | 557,051 | 617,918 |
| Belgium | 702 | 159 | 604,965 | 99,354 | 132 | 229 | 129,630 | 239,674 |
| France | 6,633 | 13,660 | 4,793,196 | 7,250,194 | 1,837 | 3,197 | 1,295,200 | 1,927,188 |
| Portugal | 661 | 359 | 559,304 | 294,872 | — | — | — | — |
| Spain | 1,238 | 514 | 1,226,778 | 497,256 | 986 | 286 | 1,372,418 | 352,481 |
| Italy | 2,258 | 967 | 4,071,225 | 2,157,962 | 454 | 115 | 902,693 | 237,833 |
| Austria Hungary | 253 | 23 | 553,581 | 59,272 | 286 | — | 645,344 | — |
| Greece | 193 | 56 | 348,448 | 110,644 | 533 | 243 | 1,003,029 | 241,227 |
| Bulgaria | 17 | 3 | 36,043 | 6,283 | — | — | — | — |
| Roumania | 81 | 1 | 160,085 | 1,152 | — | — | — | — |
| Turkey | 108 | 23 | 198,163 | 47,785 | — | — | — | — |
| Rest of Europe and Mediterranean Coasts of Africa, and Asia | 720 | 332 | 855,368 | 559,280 | — | — | — | — |
| Totals Europe and Mediterranean Coasts of Africa, and Asia | 22,433 | 19,868 | 21,073,235 | 13,652,350 | 15,421 | 12,346 | 14,553,711 | 8,367,933 |
| United Kingdom | — | — | — | — | 10,635 | 8,917 | 14,021,408 | 8,263,443 |
| British Possessions | 916 | 770 | 1,406,990 | 1,175,235 | — | — | — | — |
| Egypt | 548 | 254 | 1,276,037 | 758,660 | — | — | — | — |
| Argentine | 769 | 203 | 1,790,498 | 512,731 | — | — | — | — |
| Brazil | 465 | 69 | 1,073,427 | 162,840 | — | — | — | — |
| Uruguay | 165 | 36 | 359,939 | 97,020 | — | — | — | — |
| Chile | 198 | 6 | 476,709 | 25,189 | — | — | — | — |
| Canary Islands and Madeira | 339 | 56 | 561,074 | 116,245 | — | — | — | — |
| Africa | 168 | 191 | 296,541 | 336,367 | — | — | — | — |
| Asia | 74 | 20 | 236,914 | 85,828 | — | — | — | — |
| America (U.S.A.) | 60 | 26 | 111,373 | 65,754 | 1 | 85 | 3,324 | 143,458 |
| Rest of American Continent and Islands | 55 | 10 | 87,626 | 23,870 | — | — | — | — |
| Other Foreign Countries | — | — | — | — | 133 | 161 | 171,920 | 237,255 |
| Totals | 3,757 | 1,641 | 7,677,128 | 3,359,739 | 10,769 | 9,163 | 14,196,652 | 8,644,156 |
| Grand Totals | 26,190 | 21,509 | 28,750,363 | 17,012,089 | 26,190 | 21,509 | 28,750,363 | 17,012,089 |

## COAL PRODUCTION AND DISTRIBUTION OF THE UNITED KINGDOM. (*See diagrams on page* 459.)

| Year. | Total production. (Thousand tons.) | Home consumption. (Thousand tons.) | Exported.* (Thousand tons.) | Bunkers. (Foreign trade.) (Thousand tons.) |
|---|---|---|---|---|
| 1902 | 227,095 | 168,788 | 43,159 | 15,148 |
| 1903 | 230,334 | 168,584 | 44,950 | 16,800 |
| 1904 | 232,428 | 168,981 | 46,256 | 17,191 |
| 1905 | 236,129 | 171,256 | 47,477 | 17,396 |
| 1906 | 251,068 | 176,878 | 55,600 | 18,590 |
| 1907 | 267,831 | 185,602 | 63,610 | 18,619 |
| 1908 | 261,529 | 179,508 | 62,547 | 19,474 |
| 1909 | 263,774 | 180,983 | 63,077 | 19,714 |
| 1910 | 264,433 | 182,822 | 62,085 | 19,526 |
| 1911 | 271,892 | 188,029 | 64,599 | 19,264 |
| 1912 | 260,416 | 177,681 | 64,444 | 18,291 |
| 1913 | 287,412 | 192,980 | 73,400 | 21,032 |
| 1914 | 265,430 | 187,854 | 59,040 | 18,536 |
| 1915 | 253,179 | 196,013 | 43,535 | 13,631 |
| 1916 | 255,846 | 204,506 | 38,352 | 12,988 |
| 1917 | 248,041 | 202,817 | 34,996 | 10,228 |
| 1918 | 226,557 | 186,048 | 31,753 | 8,756 |
| 1919 | 229,037 | 181,766 | 35,250 | 12,021 |
| 1920 | 229,295 | 190,523 | 24,932 | 13,840 |

* Excluding coke and manufactured fuel.

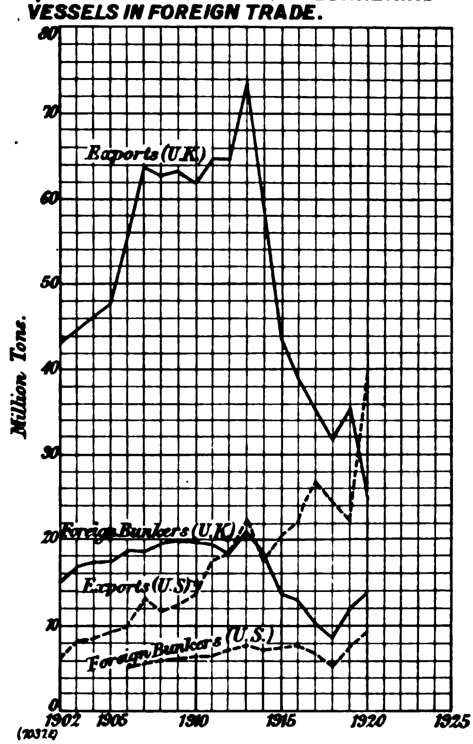
## COAL PRODUCTION AND DISTRIBUTION OF THE UNITED STATES. (*See diagrams on page* 459.)

| Year. | Total production.* (Thousand tons.) | Home consumption. (Thousand tons) | Exported. (Thousand tons.) | Bunkers. (Foreign trade.) (Thousand tons.) |
|---|---|---|---|---|
| 1902 | 269,278 | Figures not available | 6,127 | Figures not available |
| 1903 | 321,067 | " | 8,312 | " |
| 1904 | 314,122 | " | 8,573 | " |
| 1905 | 350,645 | " | 9,189 | " |
| 1906 | 369,783 | 354,736 | 9,922 | 5,125 |
| 1907 | 428,895 | 409,988 | 13,153 | 5,754 |
| 1908 | 370,838 | 352,961 | 11,853 | 6,024 |
| 1909 | 411,469 | 392,813 | 12,537 | 6,119 |
| 1910 | 449,283 | 429,031 | 13,806 | 6,446 |
| 1911 | 443,188 | 419,088 | 17,433 | 6,667 |
| 1912 | 477,202 | 451,713 | 18,149 | 7,340 |
| 1913 | 508,893 | 479,051 | 22,141 | 7,701 |
| 1914 | 458,505 | 433,607 | 17,632 | 7,266 |
| 1915 | 474,660 | 446,884 | 20,305 | 7,471 |
| 1916 | 526,874 | 495,905 | 23,143 | 7,826 |
| 1917 | 581,610 | 548,078 | 26,649 | 6,883 |
| 1918 | 595,546 | 565,622 | 24,392 | 5,532 |
| 1919 | 487,639 | 457,847 | 22,449 | 7,343 |
| 1920 | 576,485 | 527,908 | 39,215 | 9,362 |

* Figures given include both anthracite and bituminous coal.

**PRODUCTION OF COAL IN THE UNITED KINGDOM & THE UNITED STATES.**


**EXPORTS OF COAL FROM THE UNITED KINGDOM & THE UNITED STATES, ALSO QUANTITIES SUPPLIED FOR BUNKERING VESSELS IN FOREIGN TRADE.**




PRICES OF BRITISH BUNKER COALS, 1914 TO 1921.

| Class of Coal. | Average prices 1914. | | Highest and Lowest Prices. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1915 | | 1916 | | 1917 | | 1918 | | 1919 | | 1920 | | 1921 | |
| | s. | d. | s. | d. | s. | d. | s. | d. | s. | d. | s. | d. | s. | d. | s. | d. |
| Durham Bunkers— | 12 | 8½ | 30 | 0 | 42 | 6 | 26 | 6 | 75 | 0 | 100 | 0 | 120 | 0 | 60 | 0 |
| (Tyne special) . . . | | | 12 | 6 | 22 | 6 | 20 | 0 | 25 | 0 | 32 | 0 | 33 | 6 | 26 | 0 |
| Durham Bunkers— | 12 | 0½ | 25 | 0 | 39 | 0 | 24 | 0 | 65 | 0 | 90 | 0 | 115 | 0 | 52 | 0 |
| (Tyne ordinary) . . . | | | 10 | 3 | 18 | 0 | 16 | 0 | 24 | 0 | 31 | 0 | 32 | 0 | 24 | 0 |
| Cardiff Bunkers— | 9 | 6 | 23 | 6 | 34 | 0 | 21 | 6 | 28 | 6 | 85 | 0 | 97 | 6 | 55 | 0 |
| Small (class 1) . . . | | | 10 | 0 | 14 | 6 | 13 | 0 | 21 | 6 | 28 | 6 | 35 | 0 | 18 | 6 |
| Cardiff Bunkers— | 13 | 0 | 24 | 0 | 40 | 0 | 25 | 0 | 35 | 6 | 80 | 0 | 110 | 0 | 50 | 0 |
| No. 2, Rhondda through | | | 12 | 0 | 15 | 6 | 16 | 6 | 23 | 6 | 35 | 6 | 50 | 0 | 20 | 0 |

STATEMENT SHOWING THE NATIONALITY AND NET TONNAGE OF VESSELS WHICH ENTERED AND CLEARED WITH CARGOES AND IN BALLAST IN THE FOREIGN TRADE OF THE UNITED STATES OF AMERICA FOR THE YEARS ENDED 30TH JUNE, 1913 AND 1918. (*See diagram* A, *page* 461.)

| Nationality. | Entrances. | | Clearances. | | Percentages. Entrances. | | Percentages. Clearances. | |
|---|---|---|---|---|---|---|---|---|
| | 1913. | 1918. | 1913. | 1918. | 1913. | 1918. | 1913. | 1918. |
| | Tons.* | Tons.* | Tons.* | Tons.* | | | | |
| American . . . . | 13,073 | 18,460 | 13,946 | 18,761 | 25·8 | 42·0 | 27·3 | 41·7 |
| British . . . . . | 24,532 | 17,871 | 24,289 | 18,498 | 48·5 | 40·7 | 47·5 | 41·1 |
| *Other Nationalities:—* | | | | | | | | |
| Austrian . . . . | 438 | — | 424 | — | 0·9 | — | 0·8 | — |
| Belgian . . . . | 352 | 256 | 356 | 280 | 0·7 | 0·6 | 0·7 | 0·6 |
| Danish . . . . | 481 | 900 | 446 | 929 | 0·9 | 2·0 | 0·9 | 2·1 |
| Dutch . . . . | 1,049 | 317 | 1,077 | 308 | 2·1 | 0·7 | 2·1 | 0·7 |
| French . . . | 1,027 | 713 | 1,034 | 752 | 2·0 | 1·6 | 2·0 | 1·7 |
| German . . . . | 4,578 | — | 4,587 | — | 9·0 | — | 9·0 | — |
| Italian . . . . | 838 | 607 | 802 | 651 | 1·7 | 1·4 | 1·6 | 1·4 |
| Norwegian . . | 2,774 | 2,026 | 2,798 | 2,074 | 5·5 | 4·6 | 5·5 | 4·6 |
| Portuguese . . . | 14 | 92 | 15 | 103 | — | 0·2 | — | 0·2 |
| Russian . . . | 130 | 74 | 130 | 64 | 0·2 | 0·2 | 0·2 | 0·1 |
| Spanish . . . | 391 | 297 | 374 | 338 | 0·8 | 0·7 | 0·7 | 0·8 |
| Swedish . . . . | 60 | 378 | 65 | 398 | 0·1 | 0·9 | 0·1 | 0·9 |
| Japanese . . . . | 394 | 1,301 | 287 | 1,153 | 0·8 | 3·0 | 0·6 | 2·6 |
| All other Nationalities . . . . | 510 | 619 | 523 | 662 | 1·0 | 1·4 | 1·0 | 1·5 |
| Total . . . | 50,639* | 43,912* | 51,152* | 44,971* | 100·0 | 100·0 | 100·0 | 100·0 |

| | Entrances and Clearances. 1913. | 1918. | Difference. | Percentage of Total. 1913. | 1918. | Percentage. Increase or Decrease. |
|---|---|---|---|---|---|---|
| | Tons.* | Tons.* | Tons.* | | | |
| American . . . . | 27,018 | 37,221 | Increase 10,202 | 27 | 42 | Increase 38 |
| British . . . . | 48,821 | 36,369 | Decrease 12,452 | 48 | 41 | Decrease 26 |
| Other Nationalities . | 26,952 | 15,293 | Decrease 10,659 | 25 | 17 | Decrease 41 |
| Total . . . | 101,791* | 88,883* | Decrease 12,908* | 100 | 100 | Decrease 13 |

* *Figures in thousands,* i.e. *hundreds omitted.*

PROPORTION OF U.S.A. EXPORTS CARRIED IN BRITISH, AMERICAN, AND OTHER VESSELS, AS SHOWN BY THE CLEARANCES WITH CARGOES IN THE OVERSEAS TRADE OF THE UNITED STATES OF AMERICA. (*See diagram* B, *page* 461.)

| — | Clearances with Cargoes. 1913. | Percentage 1913. | 1918. | Percentage 1918. |
|---|---|---|---|---|
| | Net Tons. | | Net Tons. | |
| British Vessels . . . . . . . | 21,825,638 | 49 | 16,998,269 | 45 |
| American Vessels . . . . . | 10,917,760 | 25 | 13,596,241 | 36 |
| All other Vessels . . . . . | 11,739,449 | 26 | 7,148,007 | 19 |
| Total Clearances with Cargoes . | 44,482,847 | 100 | 37,742,517 | 100 |

## PERCENTAGE OF UNITED STATES IMPORTS AND EXPORTS CARRIED IN AMERICAN VESSELS.

(By Ten-Year Periods Generally.)

| Fiscal Year. | By Sea (including all Great Lakes water-borne foreign Commerce). In American Vessels. | In Foreign Vessels. | Total. | Per cent. American Vessels. | By Land Vehicles. | Total by Land and Sea. |
|---|---|---|---|---|---|---|
| | $ | $ | $ | | $ | $ |
| 1821 | 113,210,462 | 14,358,235 | 127,559,679 | 88·7 | — | — |
| 1830 | 129,918,458 | 14,447,970 | 144,366,428 | 89·9 | — | — |
| 1840 | 198,424,609 | 40,802,856 | 239,227,465 | 82·9 | — | — |
| 1850 | 230,272,084 | 90,764,954 | 330,037,038 | 72·5 | — | — |
| 1860 | 507,247,757 | 255,040,793 | 762,288,550 | 66·5 | — | — |
| 1870 | 352,969,401 | 638,927,488 | 991,896,889 | 35·6 | — | 991,896,889 |
| 1880 | 258,346,577 | 1,244,265,433 | 1,482,612,011 | 17·4 | 20,981,393 | 1,503,593,404 |
| 1890 | 202,451,086 | 1,371,116,744 | 1,573,567,830 | 12·9 | 73,571,263 | 1,647,139,093 |
| 1900 | 195,084,192 | 1,894,444,424 | 2,089,528,616 | 9·3 | 154,895,650 | 2,224,424,266 |
| 1910 | 260,837,147 | 2,721,962,475 | 2,982,799,622 | 8·7 | 319,132,528 | 3,301,932,150 |
| 1913 | 381,032,496 | 3,392,028,429 | 3,773,060,925 | 10·1 | 505,831,459 | 4,278,892,384 |
| 1914 | 368,359,756 | 3,417,108,756 | 3,785,468,512 | 9·7 | 473,036,293 | 4,258,504,805 |
| 1915 | 571,931,912 | 2,420,693,563 | 3,992,625,475 | 14·3 | 450,133,605 | 4,442,759,080 |
| 1916 | 948,908,216 | 4,877,132,995 | 5,826,041,211 | 16·3 | 705,325,184 | 6,531,366,395 |
| 1917 | 1,452,086,468 | 6,367,408,665 | 7,819,495,133 | 18·6 | 1,129,908,446 | 8,949,403,579 |
| 1918 | 1,688,495,946 | 6,015,204,510 | 7,703,700,456 | 21·9 | 1,161,666,318 | 8,865,366,774 |
| 1919 | 3,823,763,693 | 6,679,895,162 | 10,503,658,855 | 36·4 | 1,321,132,067 | 11,824,790,922 |
| 1920 | 5,154,337,761 | 6,830,563,705 | 11,984,901,466 | 43·0 | 1,523,256,493 | 13,508,157,959 |

Diagram A.—Showing Entrances and Clearances with Cargoes and in Ballast of British, American, and other Vessels in the Foreign Overseas Trade of the United States, 1913 and 1918.

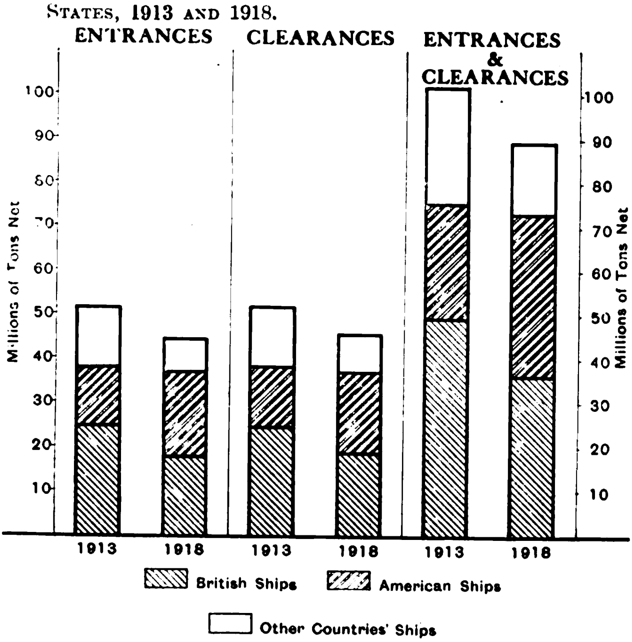
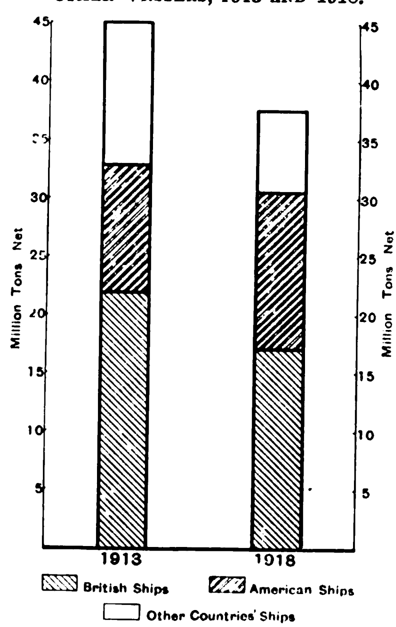



Diagram B.—Showing the Proportion of U.S. Seaborne Exports carried in British, American and other Vessels, 1913 and 1918.



## FOREIGN TRADE OF THE UNITED STATES OF AMERICA.

1913 AND 1920.

| — | Imports. | | Exports. | | Imports and Exports. | | Percentage of Total Imports. | | Percentage of Total Exports. | | Percentage of Total Imports and Exports. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. |
| | Million $. | Million $. | Million $. | Million $. | Million $. | Million $. | | | | | | |
| Overland . . . . . . . | 115.3 | 547.3 | 390.5 | 976.0 | 505.8 | 1523.3 | 6·4 | 10·4 | 15·8 | 11·9 | 11·8 | 11·3 |
| Oversea— | | | | | | | | | | | | |
| In American vessels . . | 193.1 | 1988.8 | 187.9 | 3165.6 | 381.0 | 5154.4 | 10·6 | 37·7 | 7·6 | 38·4 | 8·9 | 38·1 |
| In Foreign vessels . . . | 1504.6 | 2743.3 | 1887.5 | 4087.2 | 3392.1 | 6830.5 | 83·0 | 51·9 | 76·6 | 49·7 | 79·3 | 50·6 |
| Total Oversea . . | 1697.7 | 4732.1 | 2075.4 | 7252.8 | 3773.1 | 11984.9 | 93·6 | 89·6 | 84·2 | 88·1 | 88·2 | 88·7 |
| Grand Total . . | 1813.0 | 5279.4 | 2465.9 | 8228.8 | 4278.9 | 13508.2 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

## FOREIGN TRADE OF THE UNITED STATES OF AMERICA.

STATEMENT SHOWING THE ENTRANCES AND CLEARANCES IN THE FOREIGN TRADE OF THE UNITED STATES OF AMERICA FOR THE YEARS 1913 AND 1920.

| Nationality of Vessels. | Entrances. | | Clearances. | | Entrances and Clearances. | | Percentages. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Entrances. | | Clearances. | | Entrances and Clearances. | |
| | 1913 | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. | 1913. | 1920. |
| | Tons. | Tons. | Tons. | Tons. | Tons. | Tons. | | | | | | |
| American . . . | 13,072,567 | 32,126,000 | 13,945,801 | 34,031,000 | 27,018,368 | 66,157,000 | 25·8 | 50·1 | 27·3 | 50·2 | 26·5 | 50·1 |
| Foreign . . . | 37,566,606 | 31,999,000 | 37,206,158 | 33,790,000 | 74,772,764 | 65,789,000 | 74·2 | 49·9 | 72·7 | 49·8 | 73·5 | 49·9 |
| Total . . | 50,639,173 | 64,125,000 | 51,151,959 | 67,821,000 | 1 01,791,132 | 131,946,000 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 | 100·0 |

# THE ADMIRALTY.

## OFFICES: WHITEHALL, LONDON, S.W.1.

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*Third Sea Lord and Controller:* Rear-Admiral Frederick L. Field, C.B., C.M.G.
*Fourth Sea Lord and Chief of Supplies and Transport:* Rear-Admiral the Hon. A. D. E. H. Boyle, C.B., C.M.G., M.V.O.
*Deputy Chief of Naval Staff:* Vice-Admiral Sir R. V. B. Keyes, Bart., K.C.B., K.C.V.O., C M.G.
*Assistant Chief of Naval Staff:* Rear-Admiral Sir A. E. M. Chatfield, K.C.M.G., C.B., C.V.O.
*Civil Lord:* Bolton M. Eyres-Monsell, M.P.
*Parliamentary and Financial Secretary:* The Rt. Hon. L. C. M. S. Amery, M.P.
*Permanent Secretary:* Sir Oswyn A. R. Murray, K.C.B.
*Deputy Secretary:* Sir Charles Walker, K.C.B.
*Naval Secretary to First Lord:* Rear-Admiral H. D. R. Watson, C.B., C.B.E., M.V.O.

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ADMIRALTY ENGINEERING LABORATORY: West Drayton, Middlesex.

*Superintendent:* Engineer Commander B. W. Knott.

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*Director of Expense Accounts:* Vacant. *Assistant:* F. W. W. Burrell, O.B.E.

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ARMAMENT SUPPLY, DEPARTMENT OF THE DIRECTOR OF.

*Director:* Captain Herbert R. Norbury, C.B., R.N. *Deputy Director:* F. Ward, C.B.E. (actg.).

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TRANSPORT DEPARTMENT.

*Director:* B. A. Kemball-Cook, C.B.

MEDICAL DIRECTOR-GENERAL'S DEPARTMENT.

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*Director-General:* Paymaster Rear-Admiral W. M. C. Beresford-Whyte, C.B., C.M.G. *Deputy Director-General:* Paymaster Captain P. J. H. L. Row, C.B. *Assistant Director-General:* Paymaster Captain Gask, C.B. *Secretary to the Director-General:* Paymaster Lieut.-Commander A. S. Holborn, O.B.E.

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ADMIRALTY RESEARCH DIVISION.

*Superintendent:* A. V. Drysdale, O.B.E., D.S.O.

CIVIL ENGINEER-IN-CHIEF'S DEPARTMENT.

*Civil Engineer-in-Chief:* L. H. Savile, M.I.C.E., A.I.N.A. *Personal Assistant:* J. M. Mallett, M.B.E. *Deputy Civil Engineers-in-Chief:* C. H. Colson, O.B.E., M.I.C.E., and G. H. M. Trew, O.B.E., M.I.C.E., A.R.I.B.A. *Assistant Civil Engineer-in-Chief:* E. A. W. Barnard, O.B.E., M.I.C.E.

GREENWICH HOSPITAL DEPARTMENT.

*Director:* A. W. Smallwood, C.B.E. *Clerk-in-Charge:* A. A. Rutter.

CHAPLAIN OF THE FLEETS' DEPARTMENT.

*Chaplain of the Fleet:* The Ven. Archdeacon C. W. C. Ingles, D.D.

H.M. NAUTICAL ALMANAC OFFICE: 86, Lee Road, London, S.E. 3.

*Superintendent:* P. H. Cowell, M.A., F.R.S. *Chief Assistant:* B. F. Bawtree.

ROYAL MARINE OFFICE: 23, Carlton House Terrace, London, S.W.1.

*Adjutant-General:* Major-General H. E. Blumberg, C.B. *Assistant Adjutant-General:* Colonel R. C. Temple, O.B.E. *Deputy Assistant Adjutant-General:* B. Lieut.-Col. R. D. Ormsby.

ADMIRAL COMMANDING COASTGUARD AND RESERVES DEPARTMENT:

58, Victoria Street, London, S.W.1.

*Admiral Commanding:* Vice-Admiral Sir Morgan Singer, K.C.V.O., C.B. *Naval Assistant:* Captain George Trewby, C.M.G., D.S.O. *Secretary:* Paymaster Commander Victor C. G. Eason, O.B.E., D.S.C.

NAVAL RECRUITING DEPARTMENT, 55, Whitehall, London, S.W. 1.

*Director:* Colonel R. H. Morgan, R.M.L.I. *Assistant and Deputy-Director:* Lieut.-Col. E. G. Wharton, O.B.E., R.M.L.I.

R.N. AND R.M. RECRUITING OFFICE.

*Recruiting Staff Officer:* Major Charles Hill, R.M.L.I. (retd.).

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Shipping Federation, Ltd., Clyde District: Chairman, R. J. Dunlop, J.P.; Secretary, Walter Patterson, M.B.E., J.P.: Address, 94, Hope Street, Glasgow.

Shipping Federation, Ltd., Manchester District: Secretary, T. Whyman: Address, 115, Corn Buildings, Manchester.

Shipowners' Parliamentary Committee: Chairman, Sir William Raeburn, M.P.; Vice-Chairman, Sir Thomas Royden, Bt., C.H., M.P.; Secretary, H. M. Cleminson: Address, 28, St. Mary Axe, London, E.C. 3.

Standard Steam Ship Owners' Protection and Indemnity Association: Chairman, Charles T. Milburn; Managers, Charles Taylor & Co.: Address, 9, Fenchurch Avenue, London, E.C. 3.

Suez, Companie Universelle du Canal Maritime de: President, C. Jonnart; Chairman of London Committee and Vice-President, Sir Thomas Sunderland, G.C.M.G.; Secretary, George E. Bonnet: Address, 3, Whittington Avenue, Leadenhall Street, London, E.C. 3.

Sunderland Shipowners' Society: Secretary, Chas. Booth: Address, 44, Frederick Street, Sunderland.

Swansea Chamber of Commerce and Shipping (Shipping Section): Chairman, A. G. Moffat; Secretary, Henry J. Marshall: Address, Chamber of Commerce, Swansea.

Thames Nautical Training College: Chairman, The Rt. Hon. Lord Inchcape of Strathnaver, G.C.M.G., K.C.S.I., K.C.I.E.; Captain Superintendent, Captain M. B. Sayer, C.B.E.; Head Master, T. A. Beatty, M.A.; Secretary, F. A. Stafford: Address, 72, Mark Lane, London, E.C. 3.

Trinity House, The Honourable Company of: Master, Field-Marshal H.R.H. Duke of Connaught, K.G.; Deputy-Master, Captain Sir H. Acton Blake, K.C.M.G.; Secretary, H. G. Willett: Address, Tower Hill, London, E.C. 3.

Underwriters and Insurance Brokers in Glasgow, Association of: Committee, John M. Lamont (Chairman), Henry H. Birrell, Richard Gibson, George Jackson, Robert Law, Hugh M. Parker, and Charles G. Fulton; Secretary and Treasurer, William Stewart: Address, Underwriters' Rooms, Royal Exchange Buildings, Glasgow.

United Kingdom Mutual Steamship Assurance Association, Ltd.: Chairman, Sir Walter Runciman, Bt.; Managers, T. R. Miller & Son: Address, 24, St Mary Axe, London, E.C. 3.

West of England Steamship Owners' Protection and Indemnity Association, Ltd.: Chairman, Sir Shadforth Watts; Vice-Chairman, Sir John B. Wimble; Managers, John Holman & Sons: Address, 1, Lloyd's Avenue, London, E.C. 3.

## LIST OF PRINCIPAL BRITISH AND FOREIGN SHIPOWNERS.

Adelaide Steamship Co., Ltd., Steamship Buildings, Currie St., Adelaide, South Australia; Yuills, Ltd., 120, Fenchurch St., London, E.C. 3.

Admiral Line, Perkins Building, Tacoma, Wash., and L.C. Building, Seattle, Wash., U.S.A.

African Steamship Co., 23, Billiter St., London, E.C. 3.

Alaska Steamship Co., Pier 2, Seattle, Wash., U.S.A.

Allan Line, 25, Bothwell St., Glasgow.

American-Hawaiian Steamship Co., 8, Bridge St., New York, U.S.A.

American Line. *See* International Mercantile Marine Co., of New Jersey, and International Navigation Co., Ltd.
Anchor Line, 12 and 16, St. Vincent Place, Glasgow.
Anglo-American Oil Co., Ltd., 36, Queen Anne's Gate, Westminster, London, S.W. 1.
Anglo-Saxon Petroleum Co., Ltd., St. Helen's Court, Great St. Helen's, London, E.C. 3.
Asiatic Steam Navigation Co., Ltd., 45, St. Mary Axe, London, E.C. 3.
Atlantic, Gulf & West Indies Steamship Lines, 11, Broadway, New York, U.S.A.
Atlantic Transport Line, 9, Broadway, New York, U.S.A., and 38, Leadenhall St. London, E.C. 3.
Australasian United Steam Navigation Co., Ltd , 120, Leadenhall St., London, E.C. 3.
Australian Steamships Pty., Ltd., 35–45, Market St., Melbourne, and 33, Cornhill London, E.C. 3.
Beatley & Son, T. G., 99, Fenchurch St., London, E.C. 3.
Belfast Steamship Co., Ltd., 42 & 43, Donegall Quay, Belfast, and 5, Chapel St., Liverpool.
Bell & Co., James, Bell Chambers, Paragon St., Hull.
Ben Line Steamers, Ltd., 28, Bernard St., Leith.
Bergenske Dampskibsselskab. Det, Bergen, Norway.
Bibby Line, 26, Chapel St., Liverpool, and 138, Font St., New York, U.S.A.
Bland Line (M. H. Bland and Co., Ltd.), Cloister Building, Gibraltar.
Blue Funnel Line. *See* Holt, Alfred, & Co.
Blue Star Line, Ltd., Holland House, Bury St., London, E.C. 3.
Bombay Steam Navigation Co., Ltd., 120, Frere Road, Bombay.
Booth Line, Cunard Building, Liverpool, and 11, Adelphi Terrace, London, W.C. 2.
Bowring, & Co., Ltd., C. T., 20, Castle St., Liverpool, and Winchester House, Old Broad St., London, E.C. 2.
British and African Steam Navigation Co., Ltd., Colonial House, Water St., Liverpool.
British and Irish Steam Packet Co., Ltd., 27, Sir John Rogerson's Quay, Dublin, and 1, Seething Lane, London, E.C. 3.
British India Line, 122, Leadenhall St., London, E.C. 3; Mackinnon, MacKenzie and Co., Calcutta.
British Petroleum Co., Ltd., 22, Fenchurch St., London, E.C. 3.
British Tanker Co., Ltd., Britannic House, 23, Great Winchester St., London, E.C. 2.
Brocklebank, Ltd., T. & J. (Anchor-Brocklebank & Well Lines), Cunard Building, Liverpool.
Brodin, Erik, 14, Arsenalsgatun, Stockholm, Sweden.
Broström, Dan, 5, Packhusplatsen, Gothenberg, Sweden
Bull & Co., A. H., 40, West St., New York, U.S.A.
Burns Ltd., G. & J., 30, Jamaica St., Glasgow.
Cairn Line of Steamships, Ltd. *See* Cairns, Noble & Co., Ltd
Cairns, Noble & Co., Ltd., Akenside House, Side, Newcastle-on-Tyne.
Canadian Government Merchant Marine Ltd., 230, St. James St., Montreal, and Oriel House, 42-45, New Broad St., London, E.C. 2.
Canadian Pacific Ocean Services, Ltd., 8, Waterloo Place, Pall Mall, London, S.W. 1.
Canadian Pacific Railway Co.'s Ocean Steamship Line. *See* Canadian Pacific Ocean Services.
Canadian Steamship Lines, Ltd., 9–11, Victoria Square, Montreal.
Carlsson, G., Gothenberg, Sweden.
Chambers & Co., James, 3 & 5, King St., Liverpool.
Chargeurs Réunis, Cie. Française de Navigation à Vapeur, 1, Boulevard Malesherbes, Paris.
Chellew, R. B., Exchange Buildings, Truro, Cornwall.
China Navigation Co., Ltd., 8, Billiter Square, London, E.C. 3.
City Line (Ellerman Lines, Ltd.), 22, Water St., Liverpool, and 75, Bothwell St., Glasgow.
Clan Line (Cayzer Irvine & Co.), 2, St. Mary Axe, London, E.C. 3.
Clarke (Stephenson) & Co., 4, St. Dunstan's Alley, London, E.C. 3.
Cleveland Cliffs Iron Co., 11th Floor, Kirby Building, Cleveland, Ohio, U.S.A.
Clyde Shipping Co., Ltd., 21, Carlton Place, Glasgow, and 138, Leadenhall St., London, E.C. 3.
Clyde Steam Ship Co., Pier 36, North River, New York, U.S.A.
Coast Lines, Ltd., Royal Liver Building, Liverpool, and 1, Seething Lane, London, E.C. 3.
Commonwealth & Dominion Line, Ltd., 9 & 11, Fenchurch Avenue, London, E.C. 3.
Commonwealth Government Line of Steamers, Australia House, Strand, London, W.C. 2, and 15, O'Connell St., Sydney, Australia.

Compagnie Générale Transatlantique, 6, Rue Auber, Paris, and 4, Lloyd's Avenue, London, E.C. 3.
Compagnie Havraise Péninsulaire de Navigation à Vapeur, 10, Rue de Châteaudun, Paris.
Companhia Commercio E. Navegação, 37, Avenida Rio Branco (Caixa 482), Rio de Janeiro, Brazil.
Companhia Nacional de Navegação Costeira, 23, Rua do Hospicio, Rio de Janeiro, Brazil.
Compañia Transatlantica, Cadiz, Spain.
Compañia Trasmediterranea, Barcelona, Spain.
Cork Steamship Co., Ltd., 92, Cannon St., London, E.C. 3.
Cory Colliers, Ltd., 52, Mark Lane, London, E.C. 3.
Cory & Sons, Ltd., John, Mount Stuart House, Cardiff.
Cunard Line, Cunard Building, Pier Head, Liverpool, and 51, Bishopsgate, London, E.C. 2.
Dalgliesh, Ltd., R. S., Watergate Buildings, Sandhill, Newcastle-on-Tyne.
Dampskibsactieselskabet Otto Thoresens Linie, Prinsengade 1, Christiania.
Denmark State Railways (De Danske Statsbaner), Trommesalen, 5, Copenhagen, B., Denmark.
Det Forenede Dampskibs-Selskab, Kvaesthusgade 7 and 9B, Copenhagen, Denmark.
Dominion Line (British & North Atlantic Steam Navigation Co., Ltd.), 30, James St., Liverpool.
"Donaldson" Line, Ltd., 14, St. Vincent Place, Glasgow.
Donaldson South American Line, Ltd., 14, St. Vincent Place, Glasgow.
Eagle Oil Transport Co., Ltd., 16, Finsbury Circus, London, E.C. 2.
East Asiatic Co., Ltd. (United Baltic Corp., Ltd., 158, Fenchurch St., London, E.C. 3), 2, Holbergsgade, Copenhagen, Denmark.
Edwards & Sons, Ltd., E., Managers, Western Counties Shipping Co., Ltd., Bute St., Pierhead Chambers, Cardiff.
Elder Dempster & Co., Ltd., Colonial House, Water St., Liverpool, and 4, St. Mary Axe, London, E.C. 3.
Elders and Fyffes, Ltd., 31 and 32, Bow St., Covent Garden, London, W.C. 2.
Ellerman & Bucknall Steamship Co., Ltd., 5 & 6, Billiter Avenue, London, E.C. 3.
Ellerman Lines, Ltd., 22, Water St., Liverpool, and 12, Moorgate St., London, E.C. 2.
Ellerman's Wilson Line, Hull.
Federal Steam Navigation Co., Ltd., 2, Fenchurch Avenue, London, E.C. 3.
Fenwick, Wm. France, & Co., Ltd., 5, Fenchurch St., E.C. 3.
Finland Line Helsingfors, Finland; Chas. Gee & Co., 17, Gracechurch St., London, E.C. 3.
Fisher, Alimonda & Co., Ltd., 112, Fenchurch St., London, E.C. 3.
France, Fenwick & Co., Ltd., Wm., 5, Fenchurch St., London, E.C. 3.
Furness-Houlden Argentine Lines, Ltd., 22, Billiter St., London, E.C. 3.
Furness, Withy & Co., Ltd., Furness House, Billiter St., London, E.C. 3.
General Steam Navigation Co., Ltd., 15, Trinity Square, London, E.C. 3.
Glen Line, Ltd., 1, East India Avenue, London, E.C. 3.
Gould, J. C., & Co. (Steamship Managers), Ltd., Merthyr House, Cardiff.
Gow, Harrison & Co., 8, Gordon St., Glasgow.
Grace & Co., W. R., 1, Hanover Square, New York, U.S.A.
Green Star Steamship Corporation, 52–54, New St., New York City, N.Y., U.S.A.
Hain, Edward, & Son, Ltd., St. Ives, Cornwall.
Hall Bros., Steamship Co., Ltd., Royal Arcade, Newcastle-on-Tyne.
Hall Line, Ltd. (Owners: The Ellermann Lines, Ltd.), Tower Building, Water St., Liverpool.
Hamburg-Amerikanische Packetfahrt Actien-Gesellschaft, Alsterdamm 25, and Ferdinandstrasse 58/62, Hamburg, Germany.
Hansen, C. K., 15, Toldbodvejen, Copenhagen, Denmark.
Harrison Line, Mersey Chambers, Old Churchyard, Liverpool.
Harrison, Sons & Co., Ltd., Dowlais Buildings, Cardiff.
"Head" Line & "Lord" Line, Ulster Steamship Co., Ltd., Head Line Building, Belfast.
Henderson Line (Owners: Henderson, P., & Co.), 153, St. Vincent St., Glasgow.
Hogarth & Sons, H., 24, St. Enoch Square, Glasgow.
Holland-America Line, Rotterdam, Holland.
Holt & Co., Alfred (Blue Funnel Line), India Buildings, Water St., Liverpool.
Houlder Bros. & Co., Ltd., 146, Leadenhall St., London, E.C. 3.
Houlder, Middleton & Co., Ltd., 17, St. Helens Place, E.C. 3.
Houston Lines (R. P. Houston & Co.), 10, Dale St., Liverpool.

Huddart, Parker, Ltd., 466, Collins St., Melbourne, and 101, Leadenhall St., London, E.C. 3.
Indo-China Steam Navigation Co., Ltd., Hong Kong and 3, Lombard St., London, E.C. 3.
Instone & Co., Ltd., S., Baltic House, Docks, Cardiff, and 22, Billiter St., London, E.C. 3.
International Mercantile Marine Co., of New Jersey, Canute Road, Southampton.
International Navigation Co., Ltd., 30, James St., Liverpool.
Java-China-Japan Lijn, Prins Hendrikkade 34, Amsterdam, Holland.
Johnson, Axel Axelson, Stockholm, Sweden.
Johnston Line, Ltd., Royal Liver Building, Liverpool, and 6, Billiter St., London, E.C. 3.
Kawasaki Dockyard Co., Ltd., Kobe, Japan.
Koninklijke Hollandsche Lloyd, Prins Hendrikkade, Amsterdam, Holland.
Koninklijke Nederlandsche Stoomboot Maatschappij (Royal Nederlands Steamship Co.), Scheepvaarthuis, Prins Hendrikkade 108-114, Amsterdam, Holland.
Koninklijke Paketvaart Maatschappij (Royal Packet Navigation Co.), 112-114, Prins Hendrikkade, Amsterdam, Holland.
Koninklijke West-Indische Maidienst (Royal Dutch West India Mail), Prins Hendrikkade, 108-114, Amsterdam, Holland.
Laird Line, Ltd., 52, Robertson St., Glasgow.
Lamport & Holt, Ltd., Royal Liver Building, Pier Head, Liverpool.
Lang & Fulton, Ltd., 1, Cathcart St., Greenock.
Larrinaga & Co., Ltd., 30, James St., Liverpool.
Leith, Hull & Hamburg Steam Packet Co., Ltd., 16, Bernard St., Leith.
Leyland Line, 27 & 29, James St., Liverpool.
Lloyd Brazileiro, Praça Servulo Dourado, Rio de Janeiro, Brazil.
Lloyd Royal Belge (Great Britain), Ltd., 101, Leadenhall St., London, E.C. 3.
Lloyd Sabando Società Anonima Per Azioni, 5, Via Stottoripa, Genoa, Italy.
Lloyd Triestino Soc. Di Nav. a Vapore, Del, Trieste, Italy.
"Lord" Line. *See* "Head" Line.
MacAndrews & Co., Ltd., Suffolk House, Laurence Pountney Hill, London, E.C. 4.
MacBrayne, Ltd., David, 119, Hope St., Glasgow.
Maclay & McIntyre, 21, Bothwell St., Glasgow.
Mallory Steamship Co., Pier 36, North River, New York, U.S.A.
Manchester Liners, Ltd., 108, Deansgate, Manchester.
McIllwraith, McEacharn's Line (Proprietary), Ltd., Scottish House, 94-96, William St., Melbourne, Victoria, and Billiter Square Buildings, London, E.C. 3.
Méssageries Maritimes, Cie. des, 9, Rue de Séze, Paris, and 72-75, Fenchurch St., London, E.C. 3.
Mitsui Bussan Kaisha, Ltd. (Mitsui & Co., Ltd.), 1, Surugacho, Nihonbashi-Ku, Tokyo, Japan.
Moss & Co., H. E., 18, Chapel St., Liverpool, and 43, St. Mary Axe, London, E.C. 3.
Moss Steamship Co., Ltd., 31, James St., Liverpool.
Navigazione Generale Italiana, 6, Via Balbi, Genoa; Italian State Railways, 12, Waterloo Place, Regent St., London, S.W. 1.
"Nederland" Stoomvaart Maatschappij, 108/114, Prins Hendrikkade, Amsterdam.
Nelson, Ltd., H. & W., 98, Leadenhall St., London, E.C. 3.
New York & Cuba Mail S.S. Co. (Ward Line), Foot of Wall St., New York, U.S.A.
New York & Porto Rico Steamship Co., 11, Broadway, New York, U.S.A.
New Zealand Shipping Co., Ltd., Wellington, N.Z., and 138, Leadenhall St., London, E.C. 3.
Nippon Yusen Kabushiki Kaisha (Japan Mail Steamship Co., Ltd.), 1, Yurakucho Itchome, Kojimachi-Ku, Tokyo, Japan, and Coronation House, Lloyd's Avenue, London, E.C. 3.
Nisshin Kisen Kabushiki Kaisha (Japan-China Steamship Co., Ltd.), 1, Yurakucho Itchome, Kojimachi-Ku, Tokyo, Japan.
Norddeutscher Lloyd, Bremen, Germany.
Nordenfjeldske Dampskibs-Selskab, Det, Trondhjem, Norway.
Norske Amerika Linie A/S., Den, Strandgaten 1, Christiania, Norway.
North Coast Steam Navigation Co., Ltd., 3, Sussex St. North, Sydney, N.S.W.
Ocean Steam Navigation Co., Ltd. *See* White Star.
Orient Line to Australia, 5, Fenchurch Avenue, London, E.C. 3.
Osaka Shosen Kabushiki Kaisha, 64, Tomijimacho, Kitaku, Osaka, Japan.
Pacific Steam Navigation Co., Goree, Water St., Liverpool.
Pacific Steamship Co., L. C. Smith Building, Seattle, U.S.A.
Pan American Petroleum & Transport Co., 1015, Security Building, Los Angeles, Cal., U.S.A.
Panama Railroad Co., 24, State St., New York, U.S.A.

Pelton Steamship Co., Ltd., Milburn House, Newcastle-on-Tyne.
Peninsular & Oriental Steam Navigation Co., Inc., 122, Leadenhall St., London, E.C. 3.
P. & O. Branch Line, 32, Lime St., London, E.C. 3.
Petersen & Co., Ltd., 6, Lloyd's Ave., London, E.C. 3.
Pinillos, Irzquierdo & Co., Plaza San Augustin, 2, Cadiz, Spain.
Pollock, Sons & Co., Ltd., Sir James, 3, Lloyds Avenue, London, E.C. 3.
Prince Line, Ltd., 12, Leadenhall St., London, E.C. 3.
Radcliffe & Co., Evan Thomas, Baltic House, Cardiff.
Raeburn & Vérel, Ltd., 45, West Nile St., Glasgow.
Red Star Line, 22, Rue des Peignes, Antwerp, Holland, and 1, Cockspur St., Westminster, London, S.W. 1.
Ridley, Son & Tully, John, Milburn House, Newcastle-on-Tyne.
Rio Cape Line, Ltd. (Owners: Furness, Withy & Co., Ltd.), 12, Leadenhall St., London, E.C. 3.
Robertson, Wm., 45, West Nile St., Glasgow.
Robinson, Brown & Co., Custom House Chambers, Newcastle-on-Tyne.
Ropner & Co., Ltd., Sir R., Mercantile Chambers, Mainsforth Terrace, West Hartlepool, and 22, St. Mary Axe, London, E.C. 3.
Royal Mail Steam Packet Co., 18, Moorgate St., London, E.C. 2.
Russian Volunteer Fleet, Hovaghimian, Han, Galatea, Russia; The Borneo Co. Ltd., 28, Fenchurch St., London, E.C. 3.
Ruys & Zonen, Wm., Veerhaven, 7, Rotterdam, Holland.
Salvesen & Co., Chas., 29, Bernard St., Leith.
Shaw, Savill & Albion Co., Ltd., 34, Leadenhall St., London, E.C. 3.
Smith & Sons, Ltd., Sir W. R., Merthyr House, James St., Cardiff.
Società di Navigazione "Sicilia," Via del Giardino 76, Rome, Italy.
Società Italiana di Servizi Marittimi, Piazza Venezia 11, Rome, Italy.
Société Générale d'Armement, 1, Place Graslin, Nantes, France.
Société Générale de Transports Maritimes à Vapeur, 8, Rue Ménars, Paris.
Société Navale de l'Ouest, 8, Rue Auber, Paris.
Sota and Aznar, Bilbao, Spain, and 1, Lloyd's Avenue, London, E.C. 3.
Souter & Co., W. A., Akenside House, Akenside Hill, Newcastle-on-Tyne.
Southern Pacific Co., Atlantic Steamship Lines, 165, Broadway, New York, U.S.A.
Stern, J. (Société les Affrêteurs Réunis), 15, Rue Scribe, Paris.
Stockholms Rederiaktiebolag Svea., Skeppsbron 30, Stockholm, Sweden.
Straits Steamship Co., Ltd., St. Helen's Court, Collyer Quay, Singapore.
Strick & Co., Ltd., Frank C., Baltic House, Leadenhall St., London, E.C. 3.
Sun Shipping Co., 8, St. Helen's Place, London, E.C. 3.
Tatsuuma Kisen Kabushiki Kaisha (Tatsuuma Steamship Co.), Nishinomiya, near Kobe, Japan.
Tilbury Contracting & Dredging Co., Ltd., Queen Anne's Chambers, Westminster, London, S.W. 1.
Toyo Kisen Kabushiki Kaisha (Oriental Steamship Co., Ltd.), No. 1, 1-chome Eirakucho, Kojimachi-Ku, Tokyo, Japan.
"Transocèanic" Societa Italiana di Navigazione, Naples, Italy.
Transport Co., Ltd., 8–11, Lime St., London, E.C. 3.
Transport & Trading Co., Ltd., 17, Great St. Helens, London, E.C. 3.
Turner, Brightman & Co., 8 & 9, Great St. Helens, London, E.C. 3.
Turner & Co. *See* Asiatic Steam Navigation Co., Ltd.
Unér Aktiebolag, H., Norrköping, Sweden.
Union-Castle Line; The Union-Castle Mail Steamship Co., Ltd., 3 & 4, Fenchurch St., London, E.C. 3.
Union Steam Ship Co. of New Zealand, Ltd., Dunedin, N.Z., and 138, Leadenhall St., London, E.C. 3.
United States Steel Products Co., 30, Church St., New York, U.S.A.
United States Transport Co., Inc., 50, Broad St., New York City, N.Y., U.S.A.
Van Nievelt, Goudriaan & Co.'s, Stoomvaat Maatschappij, Rotterdam, Holland.
Van Ommeren, Phs., Westerlaan, 10, Rotterdam, Holland.
Walford (London) Ltd., Leopold, 29, Great St. Helens, London, E.C. 3.
Walford Lines, Ltd. *See* Walford (London) Ltd., Leopold.
Watts, Watts & Co., Ltd., 7, Whittington Avenue, Leadenhall St., London, E.C. 3.
Weir & Co., Andrew, Baltic Exchange Buildings, 19, 20, 21, Bury St., London, E.C. 3.
Westall, James, 13, John St., Sunderland.
Western Counties Shipping Co., Ltd. (see Edwards & Sons, Ltd.).
White Star Line; Ocean Steam Navigation Co., Ltd., 30, James St., Liverpool, and 1, Cockspur St., London, S.W. 1.
Wilhelmsen, Wilh., Christiania, Norway.

Wilson Transit Co., 948, Kirby Building, Cleveland, Ohio, U.S.A.
Witherington & Everett, Exchange Buildings, Quayside, Newcastle-on-Tyne.
Ybarra & Co., Calle San Jose 5, Seville, Spain.

## LIST OF THE PRINCIPAL BRITISH SHIPBUILDERS, MARINE ENGINEERS, AND REPAIRERS.

(*Showing in brackets after their names the output of each for* 1920.)

Abdella and Mitchell, Ltd., I. J., Queensferry, Chester, and Stroud, Gloucester (28 vessels, 3135 tons, 1570 I.H.P.).
Ailsa Shipbuilding Co., Ltd., Troon and Ayr (5 vessels, 5372 tons, 7650 I.H.P.).
Alley and MacLellan, Glasgow (15 vessels, 1170 tons).
Aitchison, Blair, Ltd., Clydebank, N.B. (3360 I.H.P.).
Amos and Smith, Ltd., Hull (10,070 I.H.P.).
Ardrossan Dry Dock and Shipbuilding Co., Ltd., Ardrossan, N.B. (5 vessels, 11,250 tons).
Armstrong, Whitworth and Co., Ltd., Sir W. G., Newcastle-on-Tyne (8 vessels, 41,229 tons, 20,000 I.H.P.).
Austin, S. P., and Co., Ltd., Sunderland (3 vessels, 4970 tons).
Ayrshire Dockyard Co., Ltd., Irvine (6 vessels, 26,618 tons).
Babcock and Wilcox, Ltd., Glasgow (52,500 I.H.P.).
Barclay, Curle and Co., Ltd., Whiteinch and Glasgow (7 vessels, 60,132 tons, 32,050 I.H.P.).
Beardmore, W. and Co., Ltd., Glasgow and Dalmuir (2 vessels, 17,716 tons, 25,080 I.H.P ).
Beazley, H. J., Southampton (13 vessels, 1075 tons).
Bergius Co., Glasgow (17,123 I.H.P.).
Bertram and Sons, Ltd., Sunderland (3 vessels, 20,332 tons).
Blair and Co., Ltd., Stockton-on-Tees (56,300 I.H.P.).
Blumer, J. and Co., Sunderland (4 vessels, 14,408 tons).
Blyth Shipbuilding and Dry Dock Co., Ltd., Blyth (7 vessels, 18,193 tons).
Bow, M'Lachlan and Co., Ltd., Paisley (7 vessels, 3822 tons, 11,190 I.H.P.).
Brown, George and Co., Greenock (3 vessels, 4393 tons).
Brown, John and Co., Ltd., Clydebank (5 vessels, 40,090 tons, 31,700 I.H.P.).
Buckley and Taylor, Oldham (2300 I.H.P.).
Burntisland Shipbuilding Co., Ltd., Burntisland (7 vessels, 18,960 tons).
Caledon Shipbuilding and Engineering Co., Ltd., Dundee (4 vessels, 23,200 tons, 10,350 I.H P.).
Cammell Laird and Co., Ltd., Birkenhead (5 vessels, 32,057 tons, 21,980 I.H.P.)
Campbell and Calderwood, Ltd., Paisley, N.B. (6100 I.H.P.).
Campbeltown Shipbuilding Co., Ltd., Campbeltown (1 vessel, 3556 tons).
Camper and Nicholsons, Ltd., Southampton (5 vessels, 680 tons).
Chalmers, W. and Co., Glasgow (19 vessels, 2319 tons).
Clark, Geo., Ltd., Sunderland (28,325 I.H.P.).
Clyde Shipbuilding and Engineering Co., Ltd., Port Glasgow (4 vessels, 8176 tons, 8340 I.H.P.).
Cockrane and Sons, Ltd., Selby, Yorks (18 vessels, 9457 tons).
Connell, Chas. and Co., Ltd., Glasgow (4 vessels, 33,570 tons).
Cook, Welton and Gemmell, Ltd., Beverley and Hull, Yorks (13 vessels, 3917 tons).
Cooper and Greig, Dundee (12,750 I.H.P.).
Crabtree and Co., Yarmouth (4 vessels, 1372 tons, 2835 I.H.P.).
Cran and Somerville, J., Leith (4 vessels, 2625 tons, 2775 I.H.P.).
Craig, Taylor and Co., Ltd., Stockton-on-Tees (4 vessels, 25,405 tons).
Crighton and Co., Ltd., Chester (28 vessels, 5050 tons, 950 I.H.P.).
Crighton, Thompson and Co., Kings Lynn (12 vessels, 1770 tons).
Crown, John and Sons, Ltd., Sunderland (2 vessels, 3840 tons).
Cumming, D. M., Glasgow (12 vessels, 1103 tons).
Day, Summers and Co., Ltd., Southampton (3 vessels, 1415 tons, 600 I.H.P.).
Denny, Wm. and Brothers, Ltd., Dumbarton (8 vessels, 3939 tons).
Dickinson, J. and Sons, Ltd., Sunderland (23,945 I.H.P.).
Dixon, Sir R. and Co., Ltd., Middlesbrough-on-Tees (6 vessels, 33,170 tons).
Dobson, W. and Co., Newcastle-on-Tyne (3 vessels, 12,660 tons).
Douglas and Grant, Kirkcaldy (12,900 I.H.P.).

Doxford, W. and Sons, Ltd., Sunderland (11 vessels, 71,270 tons, 2700 I.H.P.).
Dublin Dockyard Co., Ltd., Dublin (6 vessels, 8672 tons).
Duncan, Robt. and Co., Ltd., Port Glasgow (5 vessels, 22,773 tons).
Dundee Shipbuilding Co., Ltd., Dundee (2 vessels, 5700 tons).
Dunlop, Bremner and Co., Ltd., Port Glasgow (5 vessels, 16,208 tons, 13,500 I.H.P.).
Dunsmuir and Jackson, Glasgow (40,500 I.H.P.).
Duthie Torry Co., J., Aberdeen (5 vessels, 1104 tons).
Earle's Shipbuilding and Engineering Co., Ltd., Hull (2 vessels, 9705 tons, 25,100 I.H.P.).
Edwards and Co., Ltd., Millwall, London (8 vessels, 738 tons).
Eltringhams, Ltd., Willing Quay-on-Tyne (5 vessels, 13,419 tons, 7025 I.H.P.).
Fairfield Shipbuilding and Engineering Co., Ltd., Glasgow (3 vessels, 40,234 tons, 38,350 I.H.P.).
Fawcett, Preston and Co., Ltd., Liverpool (4080 I.H.P.).
Ferguson Bros. (Port Glasgow), Ltd., Port Glasgow (4 vessels, 5700 tons, 4750 I.H.P.).
Fleming and Ferguson, Ltd., Paisley (3 vessels, 1626 tons, 6250 I.H.P.).
Forth Shipbuilding and Engineering Co., Ltd., Alloa (6 vessels, 17,435 tons, 4050 I.H.P.).
Fullerton, John and Co., Paisley (4 vessels, 3354 tons).
Furness Shipbuilding Co., Ltd., Haverton-on-Tees (13 vessels, 72,660 tons).
Gauldie, Gillespie and Co., Ltd., Glasgow (1420 I.H.P.).
Goole Shipbuilding and Repairing Co., Ltd., Goole (4 vessels, 6252 tons).
Grangemouth Dockyard Co., Ltd., Grangemouth (4 vessels, 7840 tons).
Gray, Wm. and Co. (1918), Ltd., West Hartlepool and Sunderland (13 vessels, 56,972 tons, 57,940 I.H.P.).
Gray, W. and Co., Ltd., Sunderland (3 vessels, 15,982 tons).
Grayson, H. and Co., Ltd., Garston (5 vessels, 9474 tons).
Greenock Dockyard Co., Ltd., Greenock (3 vessels, 14,800 tons).
Grey and Co., Ltd., Geo. T., South Shields (4564 I.H.P.).
Hall, A. and Co., Ltd., Aberdeen (5 vessels, 1890 tons, 3240 I.H.P.).
Hall, Russell and Co., Ltd., Aberdeen (3 vessels, 5475 tons, 3200 I.H.P.).
Hamilton, Wm. and Co., Ltd., Port Glasgow (4 vessels, 23,374 tons).
Harkness, W. and Son, Ltd., Middlesbrough-on-Tees (4 vessels, 6717 tons).
Harland and Wolff, Ltd., Belfast (15 vessels, 82,110 tons, 48,750 I.H.P.).
Harland and Wolff, Ltd., Glasgow (4 vessels, 23,374 tons).
Harland and Wolff, Ltd. (Caird and Co., Ltd.), Greenock (2 vessels, 20,050 tons, 3200 I.H.P.).
Hawthorne, Leslie, R. W., and Co., Ltd., Newcastle-on-Tyne (8 vessels, 34,002 tons, 134,420 I.H.P.).
Hawthorns and Co., Ltd., Leith (4 vessels, 4572 tons, 8100 I.H.P.).
Henderson, D. and W. and Co., Ltd., Glasgow (4 vessels, 27,385 tons, 14,800 I.H.P.).
Hepples, Ltd., South Shields (2 vessels, 704 tons).
Hill, Charles and Sons, Ltd., Bristol (5 vessels, 12,243 tons).
Holmes, Charles D. and Co., Ltd., Hull (13,110 I.H.P.).
Hosking, T. and J., London (2250 I.H.P.).
Howden, James and Co., Glasgow (3000 I.H.P.).
Inglis, A. and J., Ltd., Glasgow (3 vessels, 6142 tons, 6900 I.H.P.).
Irvine's Shipbuilding and Dry Docks Co., Ltd., West Hartlepool (7 vessels, 32,538 tons).
Kincaid, J. G. and Co., Glasgow (78,500 I.H.P.).
Kinghorn Shipbuilding Co., Ltd., The, Leith (1 vessel, 5000 tons).
Laing, Sir J. and Co., Ltd., Sunderland (5 vessels, 26,858 tons).
Lea Shipbuilding Co., Ltd., Canning Town, London (20 vessels, 3040 tons).
Lewis, John, and Sons, Aberdeen (6 vessels, 4865 tons, 4120 I.H.P.).
Lithgows, Ltd., Port Glasgow (9 vessels, 56,161 tons).
Livingstone and Cooper, Ltd., Hull (4 vessels, 8272 tons).
Lloyd Royal Belge (Gt. Britain), Ltd., Glasgow (7 vessels, 18,339 tons).
Lobnitz and Co., Ltd., Renfrew (17 vessels, 5800 tons, 4440 I.H.P.).
London and Glasgow Engineering and Iron Shipbuilding Co., Ltd., Glasgow. *See* Harland and Wolff, Ltd., Glasgow.
London and Montrose Shipbuilding and Repairing Co., Ltd., Montrose (5 vessels, 2280 I.H.P.).
Lytham Shipbuilding and Engineering Co., Ltd., Lytham (15 vessels, 2812 tons, 4690 I.H.P.).
McColl and Pollock, Ltd., Sunderland (3750 I.H.P.).
McKie and Baxter, Govan, Glasgow (17,490 I.H.P.).
McMillan and Son, Ltd., Archibald, Dumbarton (4 vessels, 21,657 tons).

Metropolitan-Vickers, Ltd., Manchester (3200 I.H.P.).
Monmouth Shipbuilding Co., Ltd., Chepstow, Mon. (8 vessels, 40,570 tons).
Murdock and Murray, Ltd., Port Glasgow (3 vessels, 7099 tons).
Napier and Miller, Ltd., Old Kirkpatrick, nr. Glasgow (4 vessels, 16,651 tons).
Newcastle Shipbuilding Co., Ltd., Hebburn-on-Tyne (1 vessel, 3050 tons).
North British Diesel Engine Works, Ltd., Glasgow (4666 I.H.P.).
North Eastern Marine Engineering Co., Ltd., Sunderland (27,245 I.H.P.).
North Eastern Marine Engineering Co., Ltd., Wallsend-on-Tyne (64,000 I.H.P.).
North of Ireland Shipbuilding Co., Ltd., Londonderry (3 vessels, 21,200 tons).
Northumberland Shipbuilding Co., Ltd., Howden-on-Tyne (11 vessels, 59,216 tons).
Osbourne, Graham and Co., Sunderland (5 vessels, 9884 tons).
Ouse Shipbuilding and Engineering Co., Ltd., Hook, near Goole (4 vessels, 5286 tons).
Palmers Shipbuilding and Iron Co., Ltd., Jarrow-on-Tyne and Hebburn-on-Tyne (8 vessels, 46,103 tons, 42,550 I.H.P.).
Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne (17,100 I.H.P.).
Philip and Son, Ltd., Sandquay, Dartmouth (18 vessels, 882 tons, 3420 I.H.P.).
Pickersgill, W., and Sons, Ltd., Sunderland (3 vessels, 14,010 tons).
Plenty and Son, Ltd., Newbury (8104 I.H.P.).
Pollock, James, Sons and Co., Faversham (3 vessels, 686 tons).
Priestman, J. and Co., Sunderland (3 vessels, 12,680 tons).
Ramage and Ferguson, Leith (2 vessels, 3426 tons, 2400 I.H.P.).
Rankin and Blackmore, Ltd., Greenock (24,600 I.H.P.).
Readhead, John and Sons, Ltd., South Shields (5 vessels, 23,616 tons, 13,260 I.H.P.).
Rennie, Ritchie and Newport Shipbuilding Co., Ltd., Wyvenhoe (27 vessels, 5984 tons).
Rennoldson, Charles and Co., Ltd., South Shields (3 vessels, 3812 tons).
Rennoldson, J. P., and Sons, Ltd., South Shields (3 vessels, 1488 tons, 1692 I.H.P.).
Richardson, Duck and Co., Ltd., Stockton-on-Tees (5 vessels, 23,157 tons).
Richardsons, Westgarth and Co., Ltd., Sunderland (96,270 I.H.P.).
Ritchie, Graham and Milne, Glasgow (10 vessels, 2000 tons).
Rollo, D., and Sons, Ltd., Liverpool (4400 I.H.P.).
Ropner Shipbuilding and Repairing Co. (Stockton) Ltd., Stockton-on-Tees (5 vessels, 22,533 tons).
Ross and Duncan, Govan, Glasgow (12,200 I.H.P.).
Rowan, D., and Co., Glasgow (59,250 I.H.P.).
Scott and Sons, Glasgow (4 vessels, 1784 tons).
Scotts' Shipbuilding and Engineering Co., Ltd., Greenock (5 vessels, 32,000 tons, 28,600 I.H.P.).
Shields Engineering and Dry Dock Co., Ltd., North Shields (6505 I.H.P.).
Short Bros., Ltd., Sunderland (5 vessels, 33,608 tons).
Simons, Wm., and Co., Ltd., Renfrew (9 vessels, 3483 tons, 5000 I.H.P.).
Smith's Dock Co., Ltd., Middlesbrough (5 vessels, 17,116 tons, 7900 I.H.P.).
Stephen, Alex., and Son, Ltd., Glasgow (3 vessels, 25,206 tons, 16,500 I.H.P.).
Sunderland Shipbuilding Co., Ltd., Sunderland (4 vessels, 21,208 tons).
Swan, Hunter and Wigham Richardson, Newcastle-on-Tyne, Wallsend-on-Tyne, and Sunderland (17 vessels, 99,255 tons, 38,900 I.H.P.).
Thompson and Sons, Ltd., Joseph L., Sunderland (6 vessels, 32,994 tons).
Thompson, R., and Sons, Ltd., Sunderland (4 vessels, 17,541 tons).
Thornycroft and Co., Ltd., Sir J. I., Southampton (8 vessels, 8587 tons, 93,990 I.H.P.).
Tyne Iron Shipbuilding Co., Ltd., Willington Quay-on-Tyne (3 vessels, 12,268 tons).
Vickers, Ltd., Barrow-in-Furness (5 vessels, 35,400 tons, 35,350 I.H.P.).
Vickers-Petters, Ltd., Ipswich (3900 I.H.P.).
Wallsend Slipway and Engineering Co., Ltd., Wallsend (61,280 I.H.P.).
Watson (Gainsborough), Ltd., J. S., Gainsborough (36 vessels, 5444 tons).
Weir, G. and J., Ltd., Cathcart, Glasgow.
White, J. Samuel and Co., Ltd., East Cowes (42 vessels, 10,649 tons, 34,429 I.H.P.).
Wood, Skinner and Co., Ltd., Newcastle-on-Tyne (4 vessels, 7841 tons).
Workman, Clark and Co., Ltd., Belfast (6 vessels, 34,433 tons, 20,500 I.H.P.).
Yarrow and Co., Scotstoun (7 vessels, 1730 tons, 19,250 I.H.P.).

## LIST OF THE PRINCIPAL COLONIAL AND FOREIGN SHIPBUILDERS, MARINE ENGINEERS, AND REPAIRERS.

(*Showing in brackets after their names the output of each for* 1920.)

A/S Akers Mek. Verksted. Kristiana, Norway (2 vessels, 3150 tons, 1700 I.H.P.).
Alblasserdamsche Machinfabrick, Alblasserdam, Holland (3850 I.H.P.).
American International Corporation, Hog Island, Pa., U.S.A. (44 vessels, 262,400 tons).
American Shipbuilding Co. (7 yards), Cleveland, O., U.S.A. (14 vessels, 56,237 tons, 20,800 I.H.P.).
Ames Shipbuilding and Dry Dock Co., Seattle, Wash., U.S.A. (2 vessels, 11,732 tons, 6000 I.H.P.).
Andonaegui, Astilleros, Pasajes, Spain (18 vessels, 1393 tons, 2495 I.H.P.).
Ansaldo, G. and Co., Sestri Ponente, Italy (1 vessel, 6500 tons, 6000 I.H.P.).
Ansaldo, San Giorgio, Spezia, Italy (7 vessels, 40,920 tons, 20,350 I.H.P.).
Ansano Shipyard, Tsurumi, Japan (10 vessels, 54,569 tons, 36,564 I.H.P.).
Antwerp Engineering Co., Ltd. (Société Anon.), Antwerp, Belgium (3 vessels, 6765 tons).
Atlantic Corporation, Portsmouth, N.H., U.S.A. (6 vessels, 33,218 tons, 16,800 I.H.P.).
Atlas Engineering Co., Ltd., Copenhagen, Denmark (4250 I.H.P.).
Augustin-Normand, Chantiers et Ateliers, Le Havre, France (5 vessels, 2472 tons, 4000 I.H.P.).
Baltimore Dry Docks and Shipbuilding Co., Baltimore, U.S.A. (8 vessels, 52,923 tons, 19,500 I.H.P.).
Bath Ironworks, Bath, Me., U.S.A. (4 vessels, 9883 tons, 84,900 I.H.P.).
Bentley, Sons, and Co., Ltd., A., Jacksonville, Fla., U.S.A. (2 vessels, 10,000 tons).
Benz et Cie., Rheinische Automobil-Motorenfabrik, A. G., Mannheim, Germany (3150 I.H.P.).
Bergens Mekaniske Verksted, A/S, Bergen, Norway (2 vessels, 1462 tons, 1000 I.H.P.).
Bethlehem Shipbuilding Corpn. (5 yards), Bethlehem, Penn., Pa., U.S.A. (54 vessels, 263,930 tons, 247,000 I.H.P.).
Blohm and Voss, Hamburg, Germany (3 vessels, 21,000 tons, 15,000 I.H.P.).
Boele's Shipbuilding Co., Bolnes and Slikkerveer, Holland (4 vessels, 6594 tons, 4200 I.H.P.).
Bolnes, Machinefabriek, Bolnes, Holland (3380 I.H.P.).
Bohn and Mees, Rotterdam, Holland (1 vessel, 7000 tons).
Bretagne, Chantiers de, Nantes, France (3 vessels, 4110 tons).
British-American Shipbuilding Co., Ltd., Welland, Ont., Canada (2 vessels, 6194 tons).
Brodin's Warvs, Erik, Gefle, Sweden (1 vessel, 1886 tons, 1250 I.H.P.).
Burgerhout Shipbuilding and Engineering Co., Ltd., Rotterdam, Holland (2 vessels, 3850 tons, 6070 I.H.P.).
Burn and Co., Ltd., Howrah, Bengal, India (27 vessels, 7022 tons).
Burmeister and Wain, Ltd., Copenhagen, Denmark (2 vessels, 14,216 tons, 13,800 I.H.P.).
Cadiz, Astilleros de, Cadiz, Spain (5 vessels, 5586 tons).
Canadian Allis-Chambers, Bridgeburg, Ont., Canada (2 vessels, 4600 tons, 1300 I.H.P.).
Canadian Ingersoll-Rand Co., Sherbrooke, Quebec, Canada (1700 I.H.P.).
Canadian-Vickers, Ltd., Montreal, Canada (6 vessels, 32,574 tons, 17,000 I.H.P.).
Cantiere Navale, Ilva, Piomino, Italy (2 vessels, 11,000 tons).
Castellamare Dockyard, Castellamare, Italy (6 vessels, 33,900 tons, 100,000 I.H.P.).
Chantiers Maritimes du Sud-Ouest, Paris, France (5 vessels, 7790 tons).
Chantiers de la, Loire, Nantes; St. Nazaire and St. Denis, France (5 vessels, 27,800 tons, 20,700 I.H.P.).
Chickasaw Shipbuilding Co., Mobile, Ala., U.S.A. (4 vessels, 24,160 tons).
Choisy-le-roi, Chantiers de, Choisy-le-roi, France (13 vessels, 3600 tons).
Cockerill, John, and Co., Antwerp, Belgium (9 vessels, 1440 tons, 396 I.H.P.).
Collingwood Shipbuilding Co., Ltd., Collingwood, Ont., Canada (3 vessels, 5562 tons, 2450 I.H.P.).
Columbia River Shipbuilding Co., Portland, Or., U.S.A. (3 vessels, 17,598 tons).
Construzioni Navali, Cantiere Federale per, Genoa, Italy (1 vessel, 5580 tons).
Copenhagen Floating Dock and Shipyard (Kjöbenhavns Flydedok-Ogskibs A/S), Copenhagen, Denmark (5 vessels, 9658 tons, 2155 I.H.P.).
Coughlan, J., and Sons, Vancouver, B.C., Canada (6 vessels, 34,134 tons).
Cramp, W., and Sons Ship and Engine Building Co., Philadelphia, Pa., U.S.A. (15 vessels, 31,225 tons, 320,000 I.H.P.).
Davie Shipbuilding and Repairing Co., Lanzon, Levis, Quebec, Canada (5 vessels, 8242 tons).

Davis and Sons, M. M., Solomons, Md., U.S.A. (11 vessels, 11,700 tons).
De Lavals Augturbin, Aktiebolag, Stockholm, Sweden (6100 I.H.P.).
"De Schelde," Koninklijke, Maats, Flushing, Holland (2 vessels, 3163 tons, 21,800 I.H.P.).
Deutsche Werft, Aktien-Gesellschaft, Hamburg, Germany (6 vessels, 9710 tons).
Dominion Shipbuilding Co., Toronto, Ont., Canada (6 vessels, 14,506 tons, 6000 I.H.P.).
"Dordrecht" Shipbuilding Co., Ltd., Dordrecht, Holland (3 vessels, 7219 tons).
Doullut and Williams Shipbuilding Co., Inc., New Orleans, La., U.S.A. (5 vessels, 33,155 tons).
Downey Shipbuilding Corporation, Long Island, N.Y., U.S.A. (5 vessels, 17,978 tons, 10,400 I.H.P.).
Dubigeon, Chantiers, Nantes, France (3 vessels, 4110 tons).
Duthie and Co., J. F., Seattle, Wash., U.S.A. (6 vessels, 21,340 tons).
Dyle et Bacalan, Bordeaux, France (5 vessels, 3848 tons, 700 I.H.P.).
Echevarrieta y Larrinaga, Cadiz, Spain (3 vessels, 11,419 tons).
Electro Mecanique Cie, Le Bourget, France (10,000 I.H.P.).
Elsinore Shipbuilding and Engineering Co. (Aktieselskabet Helsingfors, Jernskibs-og-Maskinbyggeri), Elsinore, Denmark (4 vessels, 7647 tons, 3300 I.H.P.).
Eriksbergs Works, Gothenburg, Sweden (3 vessels, 5670 tons, 2900 I.H.P.).
Esercizio Bacini, Riva Trigoso, Italy (2 vessels, 7878 tons.).
Espanola de Construccion Metalicas, Gijon, Spain (2 vessels, 3743 tons, 3750 I.H.P.).
Euskalduna, Ca. de Construccion, Bilbao, Spain (5 vessels, 17,402 tons).
Federal Shipbuilding Co., Kearney, N.J., U.S.A. (20 vessels, 71,164 tons).
Fijenoord Co., Rotterdam, Holland (1 vessel, 1200 tons, 8170 I.H.P.).
Finnboda Varf, Aktiebolag, Stockholm 2, Sweden (1 vessel, 1664 tons).
Fletcher Co., The W. and A., Hoboken, N.J., U.S.A., (49,500 I.H.P.).
Franco Tosi, Cantieri Navali, Taranto, Italy (1 vessel, 5246 tons, 6650 I.H.P.).
Fredriksstad Mek. Verksted, Fredriksstad, Norway (7 vessels, 14,185 tons, 6850 I.H.P.).
Frichs, A/S., Aarkus, Denmark (3040 I.H.P.).
Fuginagata Shipyard, Osaka, Japan (5 vessels, 13,252 tons, 10,321 I.H.P.).
Fuller and Co., George A., Wilmington, N.C., U.S.A. (9 vessels, 58,300 I.H.P.).
General Electric Co., Schenectady, N.Y., U.S.A. (148,000 I.H.P.).
Gissen and Zonen, C. Van Der, Krimpen, Holland (2 vessels, 9200 tons).
Gironde, Chantiers des, Bordeaux, France (3 vessels, 2620 tons).
Götaverken, Gothenburg, Sweden (4 vessels, 17,075 tons, 8,750 I.H.P.).
Gouldie, M'Culloch Co., Ont., Canada (29,000 I.H.P.).
Great Lakes Eng. Works (2 yards), Detroit, Mich., U.S.A. (40 vessels, 103,518 tons, 57,600 I.H.P.).
Groton Iron Works, Groton, Conn., U.S.A. (3 vessels, 18,648 tons).
Halifax Shipyards, Ltd., Halifax, Canada (2 vessels, 11,568 tons).
Hanton Shipbuilding Co., Oakland, Cal., U.S.A. (4 vessels, 14,320 tons).
Harada Shipbuilding Co., Osaka, Japan (1 vessel, 1318 tons, 1197 I.H.P.).
Harbour Marine Co., B.C., Canada (2 vessels, 11,000 tons).
Harina Yard, near Kobe, Japan (12 vessels, 47,596 tons, 28,828 I.H.P.).
Helsingfors Ship and Engine Works, Helsingfors, Finland (1 vessel, 1500 tons, 700 I.H.P.).
Holeby Diesel Engine Works, Ltd , Holeby, Denmark (3300 I.H.P.).
Hong Kong and Whampoa Dock Co., Hong Kong (2 vessels, 5589 tons, 4300 I.H.P.)
Hoover, Owens, and Reutschler Co., Hamilton, Ohio, U.S.A. (26,500 I.H.P.).
Howaldtswerke, Kiel, Germany (3 vessels, 10,000 tons, 7000 I.H.P.).
Indian General Navigation and Railway Co., Calcutta, India (5 vessels, 2025 tons).
Inglis, J., and Co., Toronto, Ont., Canada (15,800 I.H.P.).
International Shipbuilding Co., Pascagnoula, Miss., U.S.A. (6 vessels, 20,846 tons).
Ishikawajima Shipbuilding Co., Tokyo, Japan (8 vessels, 7750 tons, 7590 I.H.P.).
Kallundborg, Skibsvaerft, Denmark (10 vessels, 7577 tons).
Kanasaki Dockyard Co., Kobe, Japan (14 vessels, 82,260 tons, 54,040 I.H.P.).
Kianguan Dock Co., Shanghai, China (5 vessels, 41,127 tons, 15,000 I.H.P.).
Koch, Henry, Lubeck, Germany (2 vessels, 12,000 tons, 4500 I.H.P.).
Kockums Mek. Verks, Malmö, Sweden (4 vessels, 6055 tons, 2800 I.H.P.).
Krupp, Fried, A/G., Kiel-Gaarden, Germany (4 vessels, 9735 tons, 10,000 tons).
Laxevaags Mack and Jernst, Bergen, Norway (2 vessels, 3180 tons, 1700 I.H.P.).
Limhamns Sheppsvau Akt., Limhamn, Sweden (4 vessels, 5287 tons, 2700 I.H.P.).
Lindholmen Co., Gothenburg, Sweden (4 vessels, 3959 tons, 3090 I.H.P.).
Llewellyn Iron Works, Los Angeles, Cal., U.S.A. (26,500 I.H.P.).
Lobithsche Scheepsbouw Maatschappij, N.V., Voor Geboreders Bodewes, Lobith, Holland (4 vessels, 13,000 tons).

Long Beach Shipbuilding Co., Long Beach, Cal., U.S.A. (6 vessels, 25,500 tons).
Los Angeles Shipbuilding and Dry Dock Co., San Pedro, Cal., U.S.A. (8 vessels, 45,840 tons, 28,000 I.H.P.).
Lyall, Wm., Shipbuilding Co., Vancouver, B.C., Canada (8 vessels, 4703 tons).
Manitowac Shipbuilding Co., Manitowac, Wis., U.S.A. (5 vessels, 5450 tons).
Marinens Hovedverft, Hortens, Norway (2 vessels, 6000 tons, 3600 I.H.P.).
Maritimes du Sud-Ouest, Chantiers, Bordeaux, France (5 vessels, 7790 tons).
Marseilles Engineering Works, Marseilles, France (2100 I.H.P.).
Maskin-och Brobygguads, Helsingfors, Finland (3 vessels, 3026 tons, 1700 I.H.P.).
McDougall-Duluth Shipbuilding Co., Riverside, Duluth, Minn., U.S.A. (10 vessels, 24,515 tons, 17,000 I.H.P.).
Méditerranée, Chantiers de la, Havre and La Seine, France (16 vessels, 8726 tons, 50,000 I.H.P.).
Merchant Shipbuilding Corp. (2 yards), Bristol, Pa., U.S.A. (28 vessels, 173,700 tons).
Mitsui Bussan Kaisha, Ltd., Kobe and Nagashi, Japan (10 vessels, 56,090 tons, 41,800 I.H.P.).
Mitsui Bussan Shipyard, Tama, Japan (4 vessels, 10,654 tons, 8420 I.H.P.).
Mobile Shipbuilding Co., Ala., U.S.A. (7 vessels, 29,725 tons).
Monflacone, Cantiere Navale, Monflacone, Italy (2 vessels, 10,374 tons).
Moore Shipbuilding Co., San Francisco, U.S.A. (3 vessels, 10,374 tons).
National Shipbuilding Corp., Quebec, Canada (10 vessels, 11,430 tons).
Netherlands Shipbuilding Co., Amsterdam, Holland (2 vessels, 11,711 tons).
Newport News Shipbuilding Co., New York, U.S.A. (10 vessels, 84,554 tons, 160,300 I.H.P.).
New York Shipbuilding Corp., Camden, New Jersey, U.S.A. (13 vessels, 147,043 tons, 48,200 I.H.P.).
New Waterway Shipbuilding Co., Schiedam, Holland (3 vessels, 22,200 tons, 5500 I.H.P.).
Niclausse, J. and A., La Villette, France (18 vessels, 2500 tons, 3000 I.H.P.).
Nobiskong Werft, Rendsberg, Germany (2 vessels, 9654 tons).
Norddeusche Werft, Bremenhaven, Germany (2 vessels, 16,024 tons).
Norduswerke, Emden, Germany (1 vessel, 12,000 tons).
North-West Steel Co., Portland, U.S.A. (3 vessels, 17,034 tons).
Oresunds Works, Landskrona, Sweden (3 vessels, 8870 tons).
Osaka Ironworks, Osaka, Japan (30 vessels, 66,215 tons, 50,530 I.H.P.).
Oskarshamns Mekaniska Verkstads Och Skeppsdockas, Aktiebolag, Oskarshamn, Sweden (1 vessel, 2000 tons, 1050 I.H.P.).
Pacific Construction Co., B.C., Canada (4 vessels, 19,736 tons).
Pacific Marine Construction Co., Santiago, Cal., U.S.A. (2 vessels, 10,000 tons).
Pensacola Shipbuilding Co., Pensacola, Flo., U.S.A. (8 vessels, 38,797 tons).
Polson Iron Works, Ont., Canada (5 vessels, 12,255 tons, 8250 I.H.P.).
Port-Arthur Shipbuilding Co., Port Arthur, Ont., Canada (4 vessels, 10,680 tons, 6550 I.H.P.).
Rotterdam Dry Dock and Shipbuilding Co. (4 vessels, 17,383 tons, 9400 I.H.P.).
Scheepswerf Navis, Groningen, Holland (21 vessels, 11,650 tons).
Schichan, F., Danzig (4 vessels, 19,850 tons, 6700 I.H.P.).
Schneider et Cie., Le Creusot, France (2400 I.H.P.).
Sestao, Astilleros de, Bilbao, Spain (2 vessels, 6000 tons).
Shanghai Dock and Engineering Co., Shanghai, China (9 vessels, 6316 tons, 6700 I.H.P.).
Skinner and Eddy Shipbuilding Corporation, Seattle, Wash., U.S.A. (3 vessels, 18,181 tons, 16,800 I.H.P.).
South-Western Shipbuilding Co., San Pedro, Cal., U.S.A. (18 vessels, 57,681 tons, 25,700 I.H.P.).
Standard Shipbuilding Corporation, New York, U.S.A. (11 vessels, 55,532 tons, 27,500 I.H.P.).
Straten Island Shipbuilding Co., Straten Island, N.Y., U.S.A. (16 vessels, 5027 tons, 9,000 I.H.P.).
Submarine Boat Corp., Newark, New Jersey, U.S.A. (50 vessels, 150,540 tons).
Taikoo Dockyard Co., Hong Kong (7 vessels, 13,660 tons, 9700 I.H.P.).
Tidewater Shipbuilding Co., Three Rivers, Quebec, Canada (2 vessels, 7,100 tons, 9700 I.H.P.).
Toledo Shipbuilding Co., Toledo, O., U.S.A. (7 vessels, 17,920 tons, 10,500 I.H.P.).
Uraga Dock Co., Kobe, Japan (10 vessels, 30,332 tons, 21,383 I.H.P.).
Union Construction Co., Oakland, Cal., U.S.A. (6 vessels, 35,946 tons).
Verschure and Co., Amsterdam, Holland (2 vessels, 3820 tons, 5550 I.H.P.).
Virginia Shipbuilding Corporation, Alexandria, Va., U.S.A. (4 vessels, 24,162 I.H.P.).
Vuijk and Sons, Capelle, Holland (4 vessels, 11,462 tons).
Vulcan Ironworks Co., Jersey City, N.J., U.S.A. (28,000 I.H.P.).

Vulcan Works, Hamburg and Stettin-Bredow, Germany (6 vessels, 35,700 tons, 30,000 tons).
Wallace Shipyards, North Vancouver, B.C., Canada (3 vessels, 9640 tons, 5000 I.H.P.).
Werf Conrad, Haarlem, Holland (6 vessels, 1170 tons).
Werkspoor Engine Works, Amsterdam, Holland (36,080 I.H.P.).
"Weser" Aktien-Gesellschaft, Bremen, Germany (1 vessel, 9000 tons, 7500 I.H.P.).
Western Canada Yards, B.C., Canada (6 vessels, 13,986 tons).
Westinghouse Co. (2 shops), New York, U.S.A. (1,016,700 I.H.P.).
Yokohama Dock Co., Yokohama, Japan (8 vessels, 42,982 tons, 29,087 I.H.P.).

## THE PRINCIPAL BRITISH STEAMSHIP SERVICES.

### A Guide for Traders and Others.

To Africa, East.
- British India Line; from London and Middlesbrough.
- Clan Line; from Glasgow, Liverpool and Newport.
- Hall Line; from Glasgow and Liverpool.
- Harrison Line; from Birkenhead and Glasgow.
- Houlder Bros. and Co., Ltd.
- Houston Line.
- Union-Castle Line.

To Africa, South.
- Aberdeen Line; from London and Plymouth.
- British Africa Shipping and Coaling Co., Ltd.; from London.
- Clan Line; from Glasgow, Liverpool and Newport.
- Harrison Line; from Birkenhead, Glasgow and Newport.
- Houlder Bros. and Co., Ltd.
- Houston Lines.
- Natal Line of Steamers, Ltd.; from London.
- Union-Castle Line.

To Africa, West.
- African Steamship Co.; from Liverpool and London.
- British and African Steam Navigation Co., Ltd.; from Liverpool and Rotterdam.
- Elder, Dempster and Co. Ltd.; from Liverpool, London and Rotterdam.
- Holt and Co. (Liverpool), Ltd.
- Houston Lines.
- Union-Castle Line.

To America, Central.
- Blue Funnel Line. *See* Holt and Co., Alfred.
- Cuban Line; from Antwerp and London.
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- Furness, Withy and Co., Ltd.
- Harrison Line; from Glasgow and Liverpool.
- Holt and Co., Alfred.
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- New Zealand Shipping Co, Ltd.; through the Panama Canal from London.
- Royal Mail Steam Packet Co.; from London.
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- Booth Line; from Havre, Liverpool, Lisbon, London and Madeira.
- British and Argentine Steam Navigation Co., Ltd.; from Liverpool.
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- Holland and Co., Ltd., Arthur; from Newport.
- Houlder Bros. and Co., Ltd.
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Ritson, F. and W.; from Glasgow, Liverpool and London.
Royal Mail Steam Packet Co.; from Hull, London, and Southampton.

To Australia and New Zealand.
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Commonwealth and Dominion Line; from London and West Coast ports of Great Britain.
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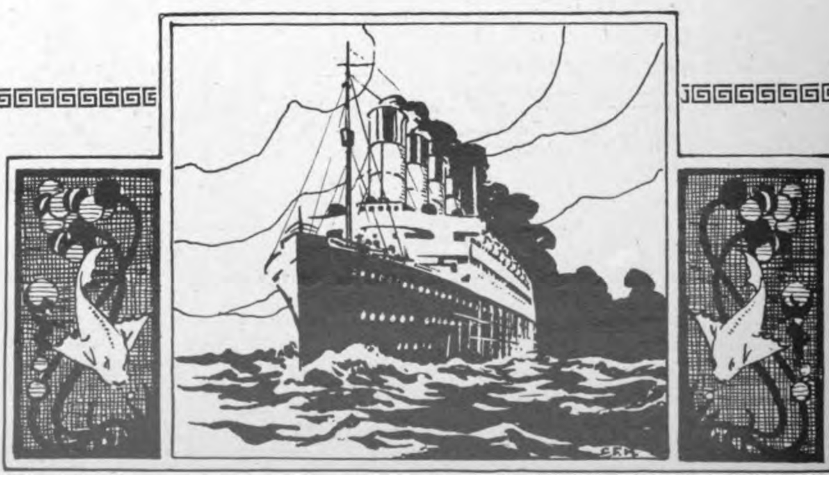

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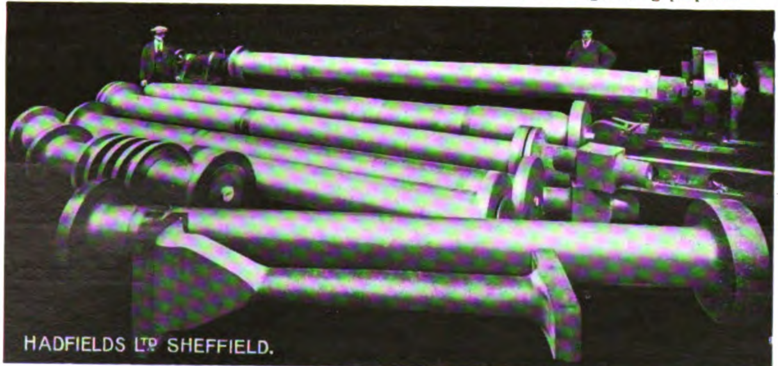


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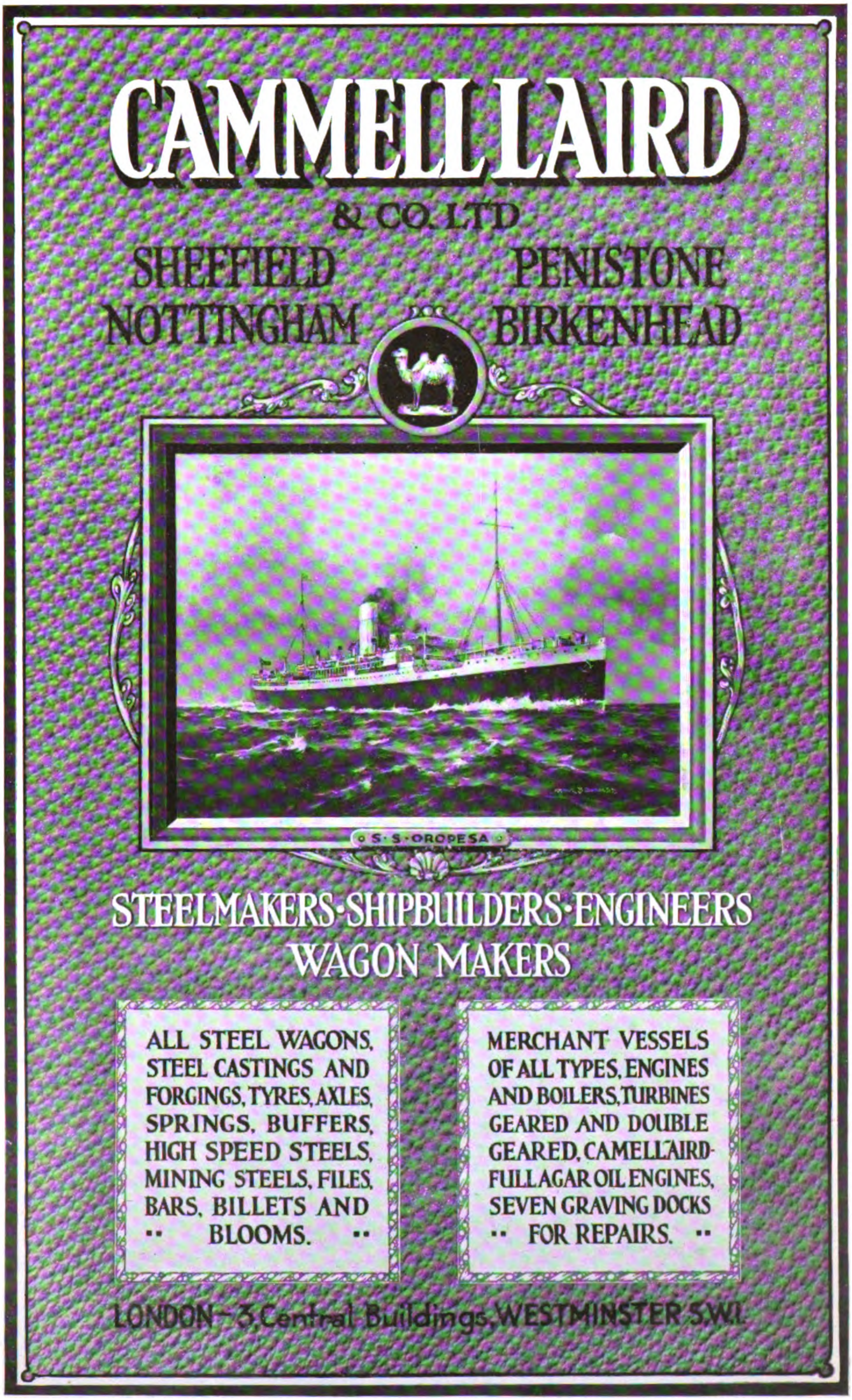
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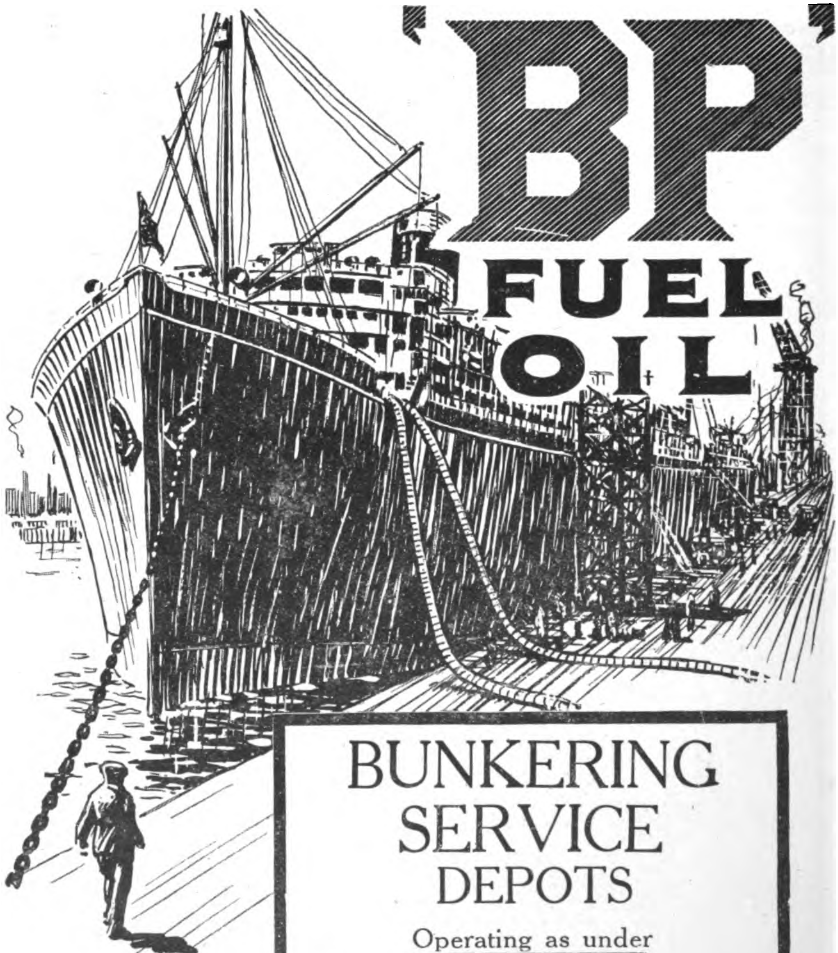


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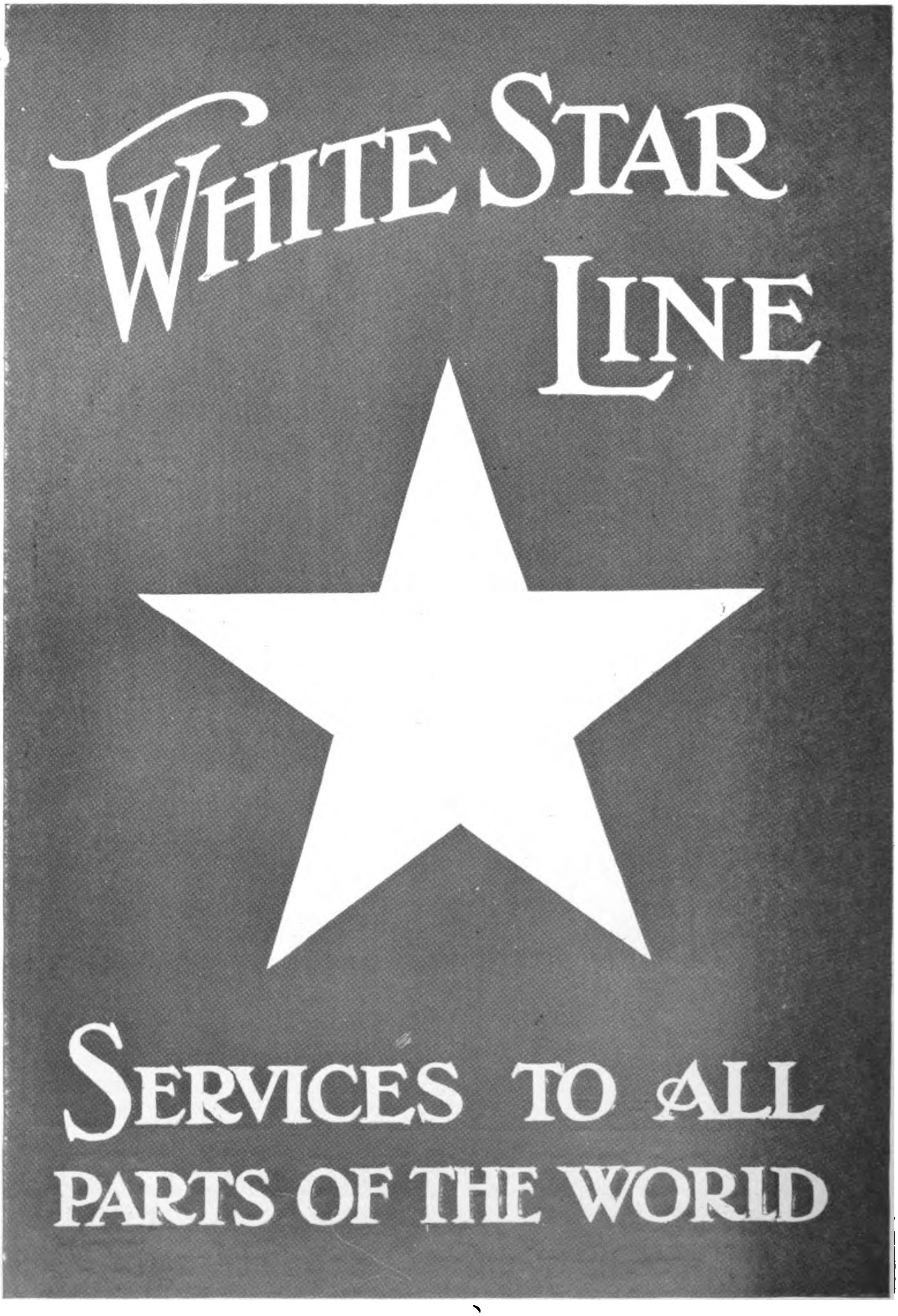
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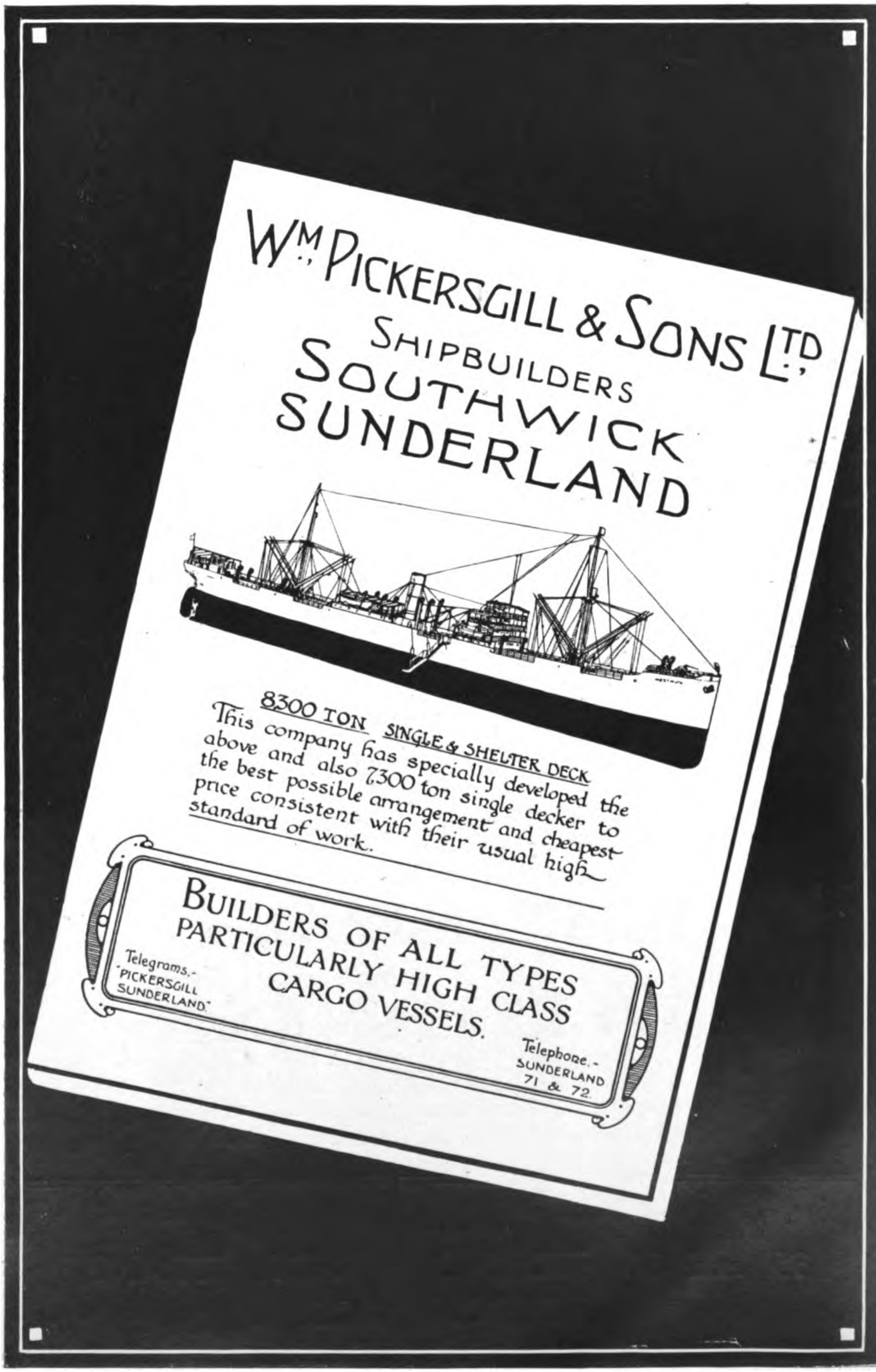
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